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SA23
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SSME ALTERNATE TURBOPUMP DEVELOPMENT PROGRAM (HPFTP)

VERIFICATION COMPLETE REPORT FIRST TURBINE VANE AERODYNAMIC DESIGN DVS DR NO. 3.1.2.2.4.1, VM NO. 4.1.2.4 A

JUNE 1989

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Marshall Space Flight Center, AL 35812

Prepared by
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West Palm Beach, FL 33410-9600

(NASA-CR-183756) SSME ALTERNATE TURBOPUMP
DEVELOPMENT PROGRAM (HPFTP). VERIFICATION
COMPLETE REPORT. FIRST TURBINE VANE
AERODYNAMIC DESIGN (PWA) 51 p

N90-70267

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HPFTP Turbine Aerodynamic Design

The High Pressure Fuel Turbopump (HPFTP) turbine aerodynamic design is based on the requirements defined by the Interface Control Document (ICD) and by the Power Balance Model, Table 387B. Performance Table 387B was used for the turbine aerodynamic design because its turbine flow capacities are consistent with the baseline turbine nozzle flow test results conducted on Pratt & Whitney's test stand, E-6, in December, 1986.

A conventional pressure-compounded, 2-stage turbine was chosen because of its inherent high efficiency over a wide range of steady-state operating conditions. No exit guide vane is required for the small (18 degrees) exit swirl angle. The high airfoil gas bending loads in the HPFTP turbine required thin wall, hollow airfoil sections, with larger moments of inertia, in order to reduce the airfoil bending stresses. The HPFTP turbine design has a mean diameter wheel speed of 1482 ft/sec which is compatible with allowable disk and root attachment stress criteria. This wheel speed also provides a high design point wheel speed to gas velocity ratio, assuring that there will not be a significant efficiency loss at minimum power level (MPL) operation. The design point velocity ratio, (0.55) is conservative, ensuring minimal aerodynamic risk. The design speed of approximately 36,500 rpm selected for the HPFTP was primarily set by the pump hydrodynamics. The height of the turbine annulus was selected to limit the last stage blade root centrifugal stress to 46,000 psi. This annulus size yielded a favorable exit Mach number of 0.18 and a low exit swirl angle of 18 degrees, therefore, this rpm was satisfactory to the performance, stress, and exit Mach number requirements of the turbine.

The methodology associated with the design of the HPFTP starts with the meanline design analysis. This analysis is based on the assumption that the flow through the turbine can be represented by the flow at the center of the flow passage. This simplified approach permits selection of the number of stages required, the mean diameter of the flow passage, and the annulus area. Included in the analysis is an estimate of the aerodynamic efficiency. This prediction system uses the physical laws of aerodynamics and correlations from rig and engine data to estimate profile loss, secondary loss, blade tip leakage, and shock and incidence losses based on the geometry and aerodynamic parameters of the turbine. An interactive graphic flowpath design system is used, in conjunction with the optimum meanline design, to generate candidate flowpath configurations.

The streamline design analysis is used to optimize the radial variation in the velocity triangles, once the average conditions are selected from the meanline analysis. This analysis calculates the flow characteristics at numerous radial locations and at the inlet and exit of each airfoil row. Once the meanline and streamline analyses have been used to optimize the velocity triangles throughout the turbine, 2 dimensional (2-D) airfoil sections are designed. These airfoil sections are designed to achieve contours that provide the desired amount of flow turning without permitting the flow to separate from

the airfoil surface. This process involves determining the static pressure distributions and boundary layer parameters along the airfoil surfaces and endwalls. An interactive graphics airfoil design system is used to identify adverse static pressure gradients such that the airfoil contour can be modified appropriately. After the 2-D airfoils are estimated at several spanwise locations, they are radially faired and combined with a preliminary endwall definition. An inviscid multi-stage 3-D flow analysis is then used to refine and optimize the entire flowpath configuration.

All turbine airfoil, endwall, inlet, and exit flow passage surfaces are contoured and refined as a system. The multi-stage feature enables a complete evaluation of potential changes to an individual surface contour during the design process. This assessment includes, not only flow property changes around the component being modified, but also around all upstream and downstream components in the complete turbine system. Improved performance and reduced risk result from this global optimization capability.

This report contains:

- o Hot elevation diagrams for each airfoil
- o 3-D airfoil plots
- o 2-D airfoil section plots
- o Tabulated airfoil section coordinates
- o A plot of hot gaging dimensions versus radius
- o A plot of percent change in flow area versus airfoil rotation
- o A plot of stress versus span
- o 3-D airfoil static pressure distributions
- o Airfoil Ps/PT and Mach number contours
- o A plot of suction surface boundary layer friction coefficient versus surface distance

COVER SHEET

S.S.M.E.
ENGINE Alternate Turbo-Pump Development

AIRFOIL 1st Stage Vane

ENGINEER R.J. Rowey EXT 5962 DATE 8/24/87

AERODYNAMIC DESIGN POINT 109% Power - Design Table 0387.B dated 4/10/87

F.T.D. LIST:

ELEVATION _____

GAGING VS. RADIUS _____

AIRFOIL SECTIONS _____

FLOW AREA VS. ROTATION _____

AIRFOIL COORDINATES _____

STRESS VS. % SPAN _____

PRESSURE DIST. _____

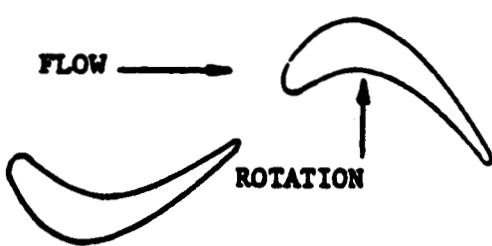
BOUNDARY LAYER _____

DF LIST:

CHECK ONE

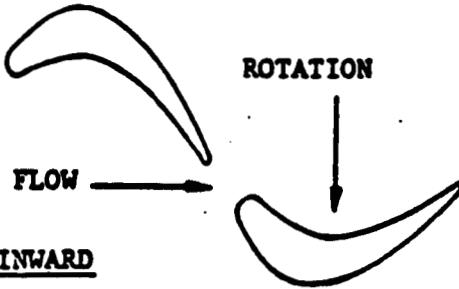
P&WA CONVENTIONAL ROTATION

VANE _____ BLADE

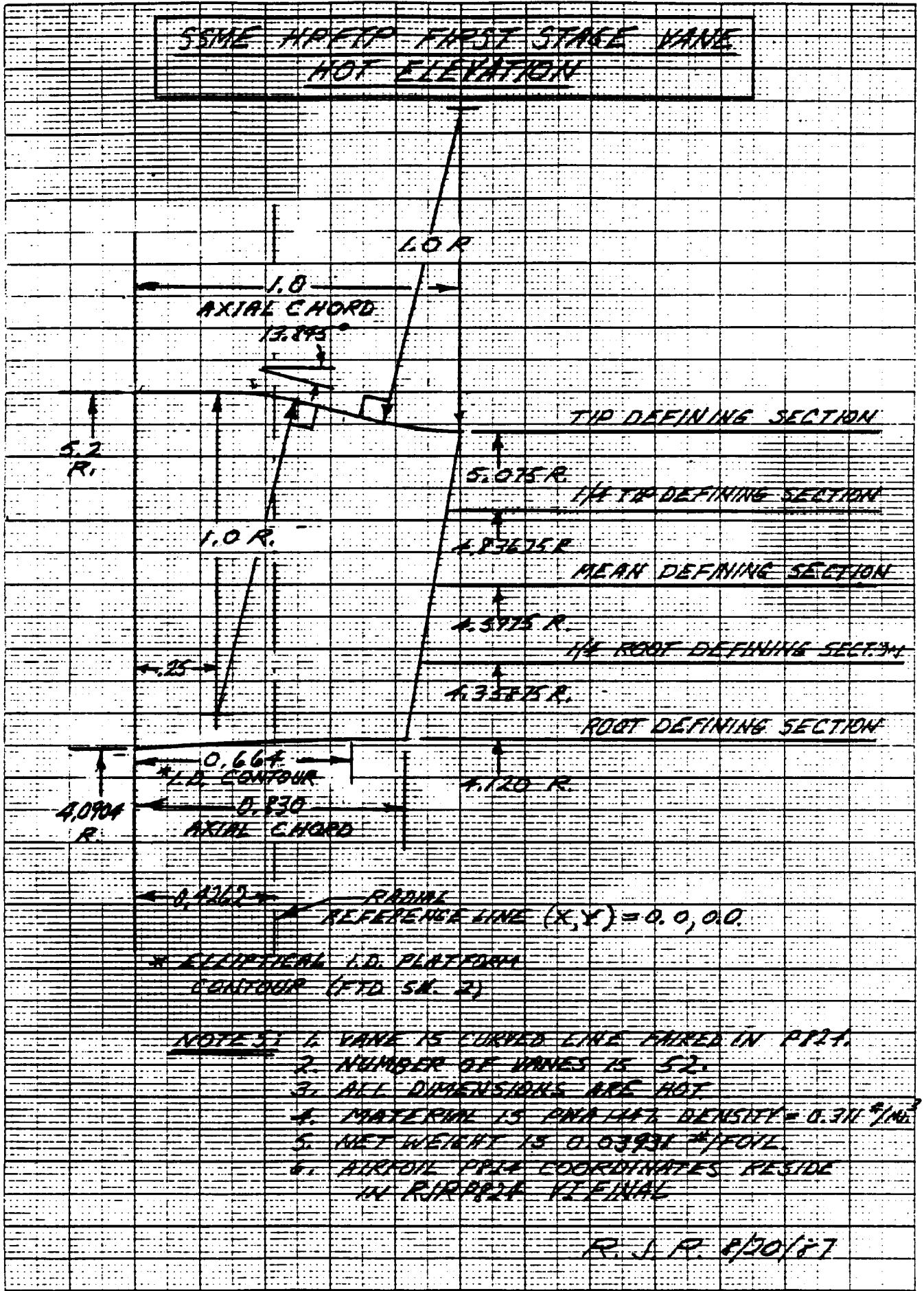


P&WA COUNTER ROTATION

VANE _____ BLADE _____



VIEW LOOKING RADIALLY INWARD



SHEET HPFTP FIRST STAGE VANE INNER PLATFORM HOT CONTOUR

DEFINITION (REFER TO P824 FILE RJP824 VFINAL

AND FTD SHEET 1 HOT ELEVATION

(GENERATED FROM FTP00 EXEC, R.J.RONEY)

X-HOT, IN.

R-HOT, IN.

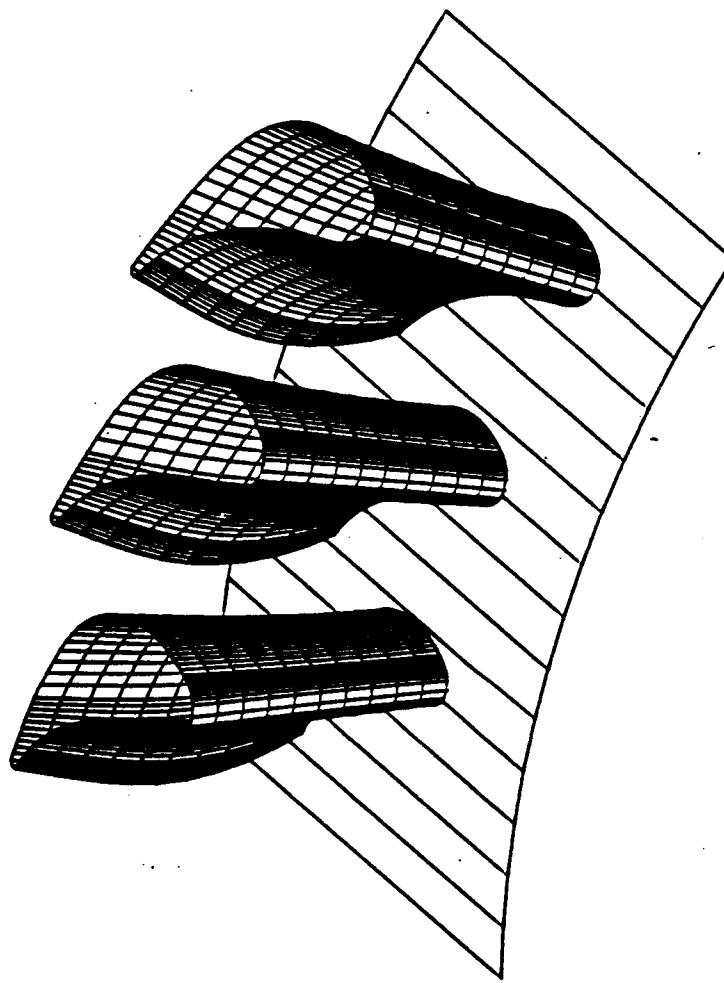
FIRST STAGE VANE LEADING EDGE

FIRST STAGE VANE RADIAL REFERENCE LINE

FIRST STAGE VANE TRAILING EDGE

-0.42624	4.07225	FIRST STAGE VANE LEADING EDGE
-0.39304	4.07693	
-0.35984	4.08136	
-0.32664	4.08555	
-0.29344	4.08950	
-0.26024	4.09321	
-0.22704	4.09667	
-0.19384	4.09989	
-0.16064	4.10287	
-0.12744	4.10561	
-0.09424	4.10811	
-0.06104	4.11057	
-0.02784	4.11239	
0.00000	4.11391	
0.00536	4.11418	
0.03856	4.11572	
0.07176	4.11703	
0.10496	4.11810	
0.13816	4.11893	
0.17136	4.11952	
0.20456	4.11988	
0.23776	4.12000	
0.40376	4.12000	FIRST STAGE VANE TRAILING EDGE

3D PLOT



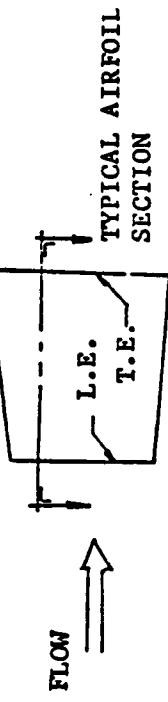
SSME FINAL FT IV...R.J. ROWEY...5-14-87..

05/26/87 15:40:57
29.11 48.59 49.11

SSME FT FINAL IV. R.J. ROWLEY. 6-10-87. CANT MG. MYG

L.E. ROOT

CYLINDRICAL
SCALE 5.0
THERMAL SHRINK FACTOR 1.00000
08/19/87
11:11:20

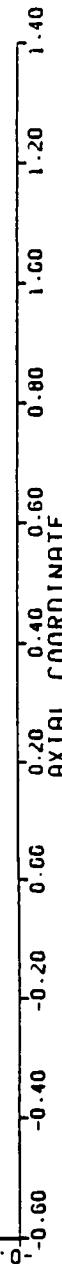
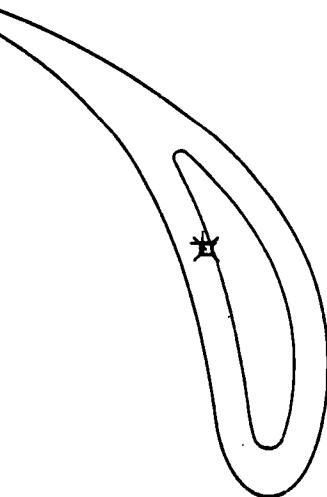


ENGINE

CLOCKWISE ROTATION WHEN LOOKING FORWARD

NOMINAL ENGINE POSITION

NUMBER OF VANES	52.
RADIUS (HOT)	4.072 INCHES
GAGING (HOT)	0.2171 INCHES
PITCH (HOT)	0.4921 INCHES
AXIAL WIDTH	0.8215 INCHES
VANE INLET ANGLE	89.537 DEGREES
GAS INLET ANGLE	90.000 DEGREES
VANE EXIT ANGLE	25.945 DEGREES
GAS EXIT ANGLE	24.927 DEGREES
GAGING ANGLE	26.173 DEGREES
UNCOVERED TURNING	19.091 DEGREES
LEADING EDGE RADIUS	0.0487 INCHES
TRAILING EDGE RADIUS	0.0176 INCHES
TOTAL AREA (SOLID)	0.1351 SQ. IN.
METAL AREA	0.0981 SQ. IN.
(NET, UNCOATED)	



X C.G.
+ STACKING LINE
CAGE

X -0.0097
+ 0.0000
CAGE 0.1999

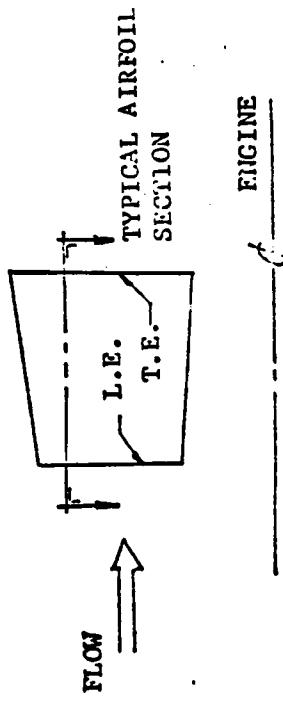
Y -0.0054
+ 0.0000
CAGE 0.0010

SSME FT FINAL iv... R.J.ROWELL.. 6-10-87. CANT MXG. MYG.

T.E. ROOT

CYLINDRICAL
SCALE 5.0
THERMAL SHRINK FACTOR 1.00000
08/19/87
11:11:26

NUMBER OF VANES	52.
RADIUS (HOT)	4.120 INCHES
GAGING (HOT)	0.2081 INCHES
PITCH (HOT)	0.4978 INCHES
AXIAL WIDTH	0.8300 INCHES
VANE INLET ANGLE	90.000 DEGREES
GAS INLET ANGLE	90.000 DEGREES
VANE EXIT ANGLE	24.120 DEGREES
GAS EXIT ANGLE	24.120 DEGREES
GAGING ANGLE	24.712 DEGREES
UNCOVERED TURNING	19.878 DEGREES
LEADING EDGE RADIUS	0.0494 INCHES
TRAILING EDGE RADIUS	0.0175 INCHES
TOTAL AREA (SOLID)	0.1419 SQ. IN.
METAL AREA	0.1014 SG. IN.
'NET. UNCOATED'	

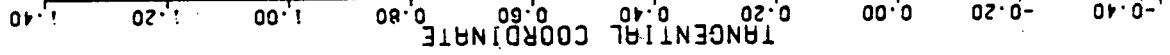


CLOCKWISE ROTATION WHEN LOOKING FORWARD

NOMINAL ENGINE POSITION

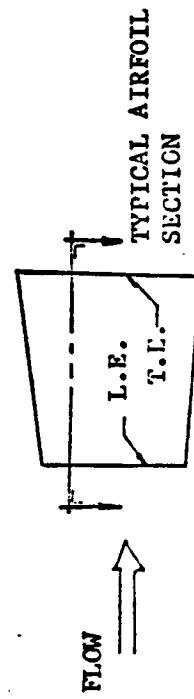
X C.G.
+ STACKING LINE
CRGE

X C.G.
+ STACKING LINE
CRGE



SSME FT FINAL iv. R. J. ROWLEY . 6-10-87. CANT MXG. MYG.

1/4 ROOT

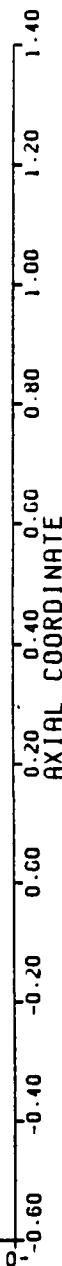
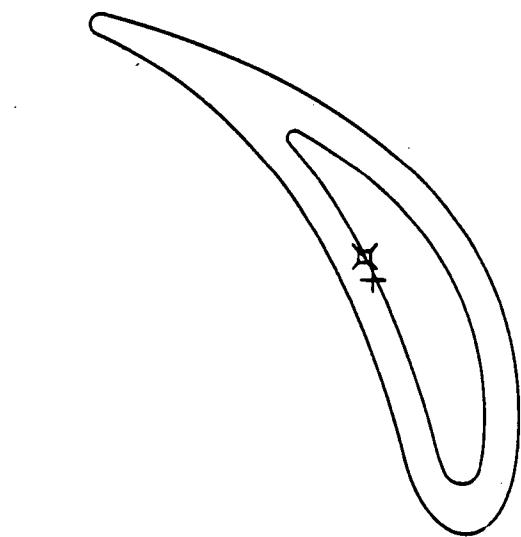


CYLINDRICAL
SCALE 5.0
THERMAL SHRINK FACTOR 1.000000
08/19/87
11:11:20

NUMBER OF VANES	52.
RADIUS (HOT)	4.359 INCHES
GAGING (HOT)	0.813 INCHES
PITCH (HOT)	0.5267 INCHES
AXIAL WIDTH	0.8725 INCHES
VANE INLET ANGLE	91.611 DEGREES
GAS INLET ANGLE	90.000 DEGREES
VANE EXIT ANGLE	19.421 DEGREES
GAS EXIT ANGLE	19.421 DEGREES
GAGING ANGLE	20.133 DEGREES
UNCOVERED TURNING	20.226 DEGREES
LEADING EDGE RADIUS	0.6523 INCHES
TRAILING EDGE RADIUS	0.0174 INCHES
TOTAL AREA (SOLID)	0.730 SQ. IN.
METAL AREA	0.1149 SQ. IN.
(NET. UNCOATED)	

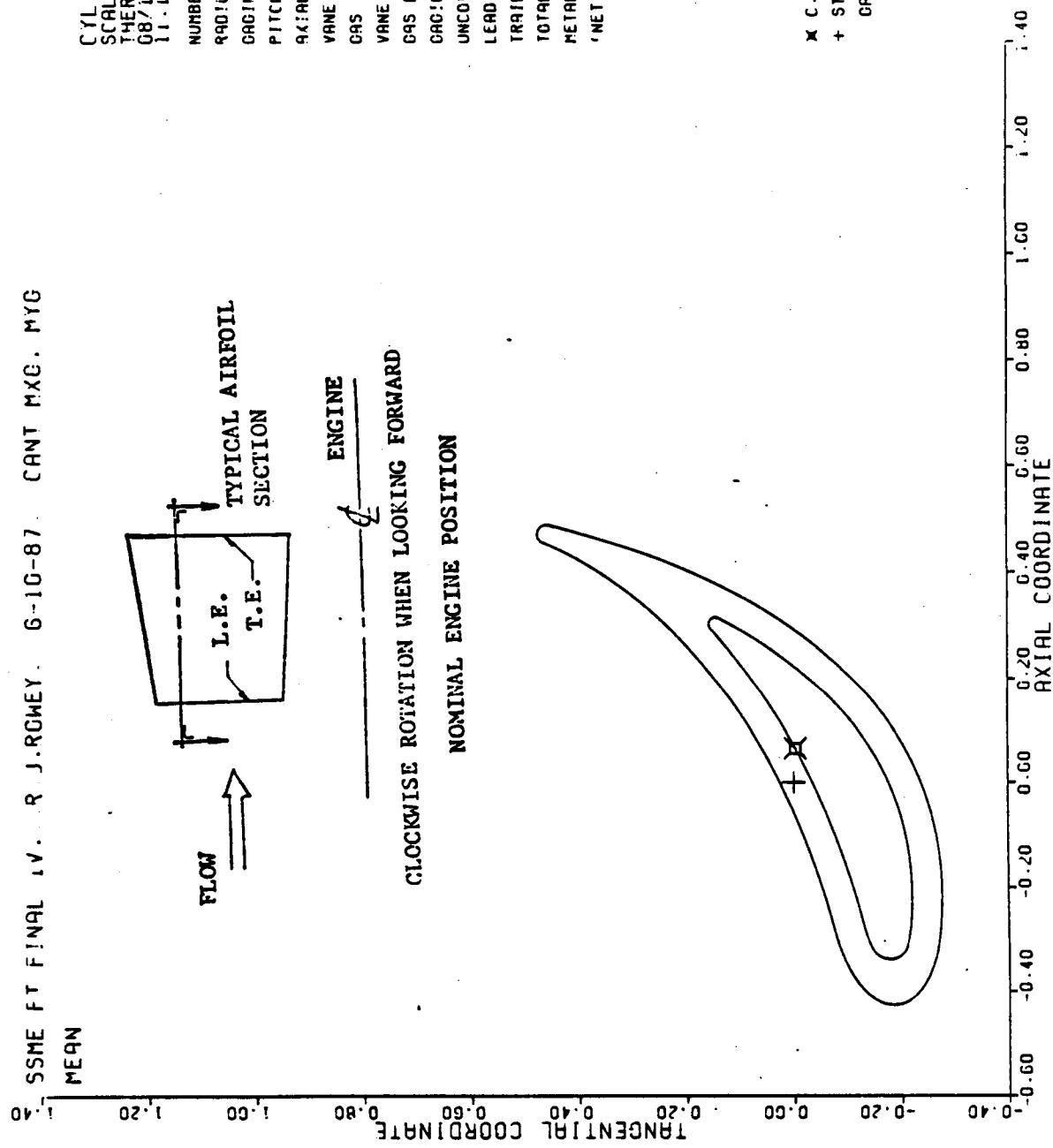
CLOCKWISE ROTATION WHEN LOOKING FORWARD

NORMAL ENGINE POSITION



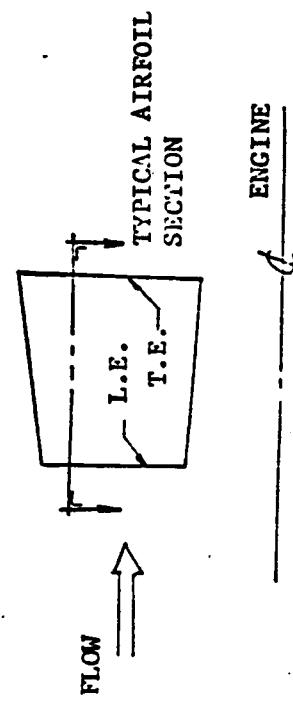
SSME FT FINAL IV. R. J. ROMNEY 6-16-87 CANT MXG. MYG

MEAN



SSME FT FINAL IV. R. J. ROWLEY. 6-10-87 CANT MYG. MYG.

1/4 TIP

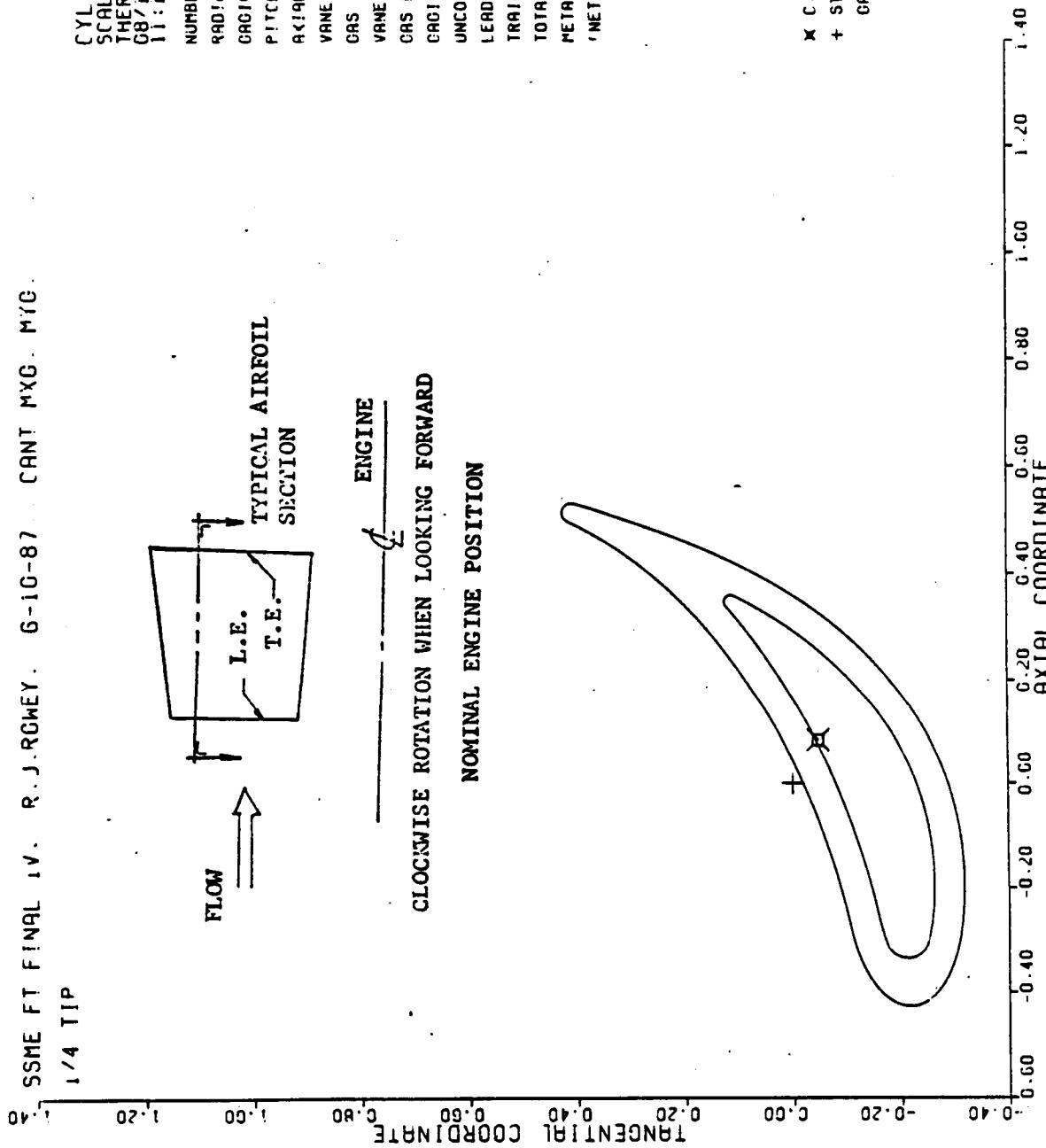


CLOCKWISE ROTATION WHEN LOOKING FORWARD

NOMINAL ENGINE POSITION

CYLINDRICAL	SCALE 5:6	THERMAL SHRINK FACTOR 1.00000
08/19/87		
11:11:26		
NUMBER OF VANES	52.	
RADIUS (HOT)	4.836 INCHES	
CAGING (HOT)	0.2080 INCHES	
PITCH (HOT)	0.5844 INCHES	
AIRL WIDTH	0.9575 INCHES	
VANE INLET ANGLE	91.01 DEGREES	
GAS INLET ANGLE	90.000 DEGREES	
VANE EXIT ANGLE	20.616 DEGREES	
GAS EXIT ANGLE	20.616 DEGREES	
CAGING ANGLE	20.850 DEGREES	
UNCOVERED TURNING	20.211 DEGREES	
LEADING EDGE RADIUS	0.0576 INCHES	
TRAILING EDGE RADIUS	0.0176 INCHES	
TOTAL AREA (SOLID)	0.2100 SQ. IN.	
METAL AREA	0.1275 SQ. IN.	
'NET' UNCOVERED)		

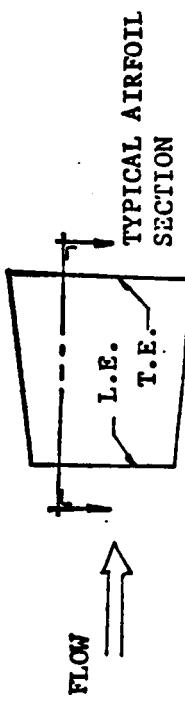
X C.C.	X	Y
+ STACKING LINE	0.0000	0.0006
CAGE	0.3316	-0.0420



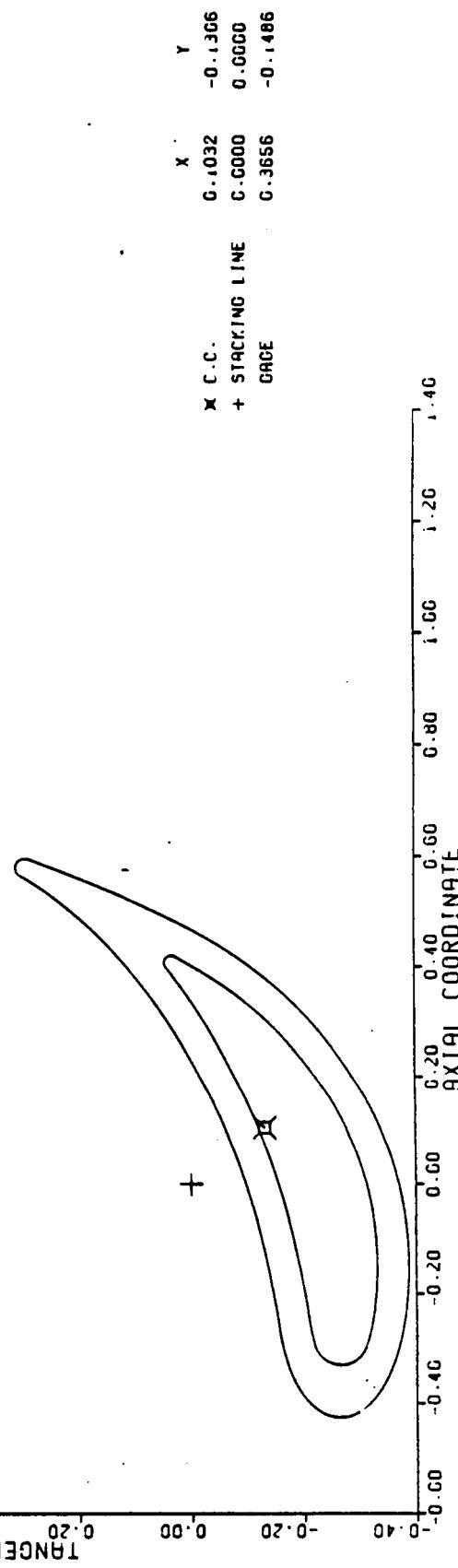
SSME FT FINL IV. R. J. ROWLEY. 6-10-87 CANT M/C. M/C.
I.E. TIP

CYLINDRICAL
SCALE 5.0
THERMAL SHRINK FACTOR 1.00000
08/19/87
11 11.20

NUMBER OF VANES	52.
RADIUS (HOT)	.5.200 INCHES
GAGING (HOT)	.0.2665 INCHES
SPACER (HOT)	.0.6283 INCHES
AXIAL WIDTH	.1.0223 INCHES
VANE INLET ANGLE	.89.481 DEGREES
GAS INLET ANGLE	.90.000 DEGREES
VANE EXIT ANGLE	.26.228 DEGREES
GAS EXIT ANGLE	.26.228 DEGREES
GAGING ANGLE	.24.992 DEGREES
UNCOVERED TURNING	.19.284 DEGREES
LEADING EDGE RADIUS	.0.0612 INCHES
TRAILING EDGE RADIUS	.0.0173 INCHES
TOTAL AREA (SOLID)	.0.2260 SQ. IN.
METAL AREA	.0.1309 SQ. IN.
NET UNCOATED	



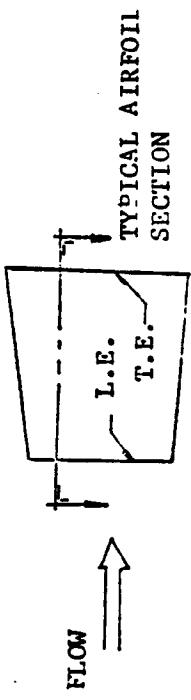
CLOCKWISE ROTATION WHEN LOOKING FORWARD
NOMINAL ENGINE POSITION



SSME FT FINAL IV. R. J. ROMNEY 6-10-87 CANT MAG. MYG.

T.E. TIP

CYLINDRICAL
SCALE 5.0
THERMAL SHRINK FACTOR 1.00000
08/19/87
11:11:20

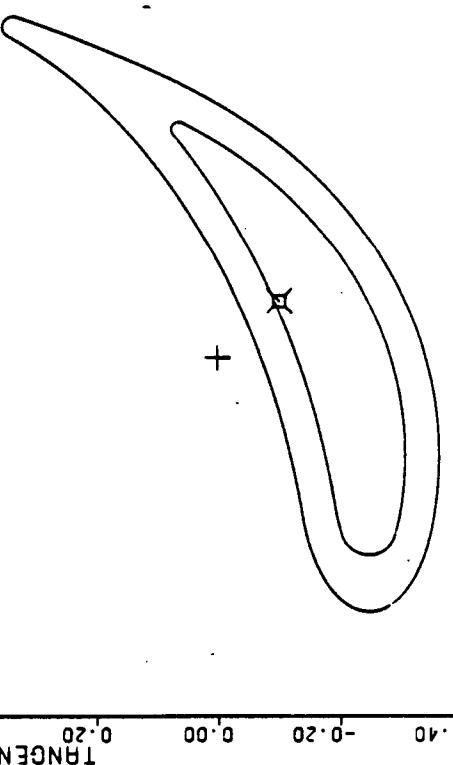


ENGINE

CLOCKWISE ROTATION WHEN LOOKING FORWARD

NOMINAL ENGINE POSITION

NUMBER OF VANES	52.
RADIUS (HOT)	5.075 INCHES
GAGING (HOT)	0.452 INCHES
PITCH (HOT)	0.6132 INCHES
X:R WIDTH	1.000 INCHES
VANE INLET ANGLE	90.000 DEGREES
GAS INLET ANGLE	90.000 DEGREES
VANE EXIT ANGLE	24.103 DEGREES
GAS EXIT ANGLE	24.103 DEGREES
GAGING ANGLE	23.573 DEGREES
UNCOVERED TURNING	19.946 DEGREES
LEADING EDGE RADIUS	0.0660 INCHES
TRAILING EDGE RADIUS	0.0175 INCHES
TOTAL AREA (SOLID)	0.2204 SQ. IN.
METAL AREA (NET, UNCGATED)	0.1298 SQ. IN.



EXTERNAL 'OUR
TD 0 0 REV. 0 PART NO.
SUBTITLE L.E. ROOT

TITLE - SSME FT FINAL 1V...R.J.RONEY...6-
END NO. DATE 08/19/87 TIME 11:10:56
HOT RADIUS = 4.07250 COLD RADIUS = 4.02591 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.42624	-0.11940	-0.10606	-0.42624	-0.09242	-0.10606
0.010	-0.41802	-0.13314	-0.11802	-0.7898	-0.07898	
0.020	-0.40981	-0.14406	-0.40981	-0.06835		
0.030	-0.40159	-0.15215	-0.40159	-0.06054		
0.040	-0.39338	-0.15874	-0.39338	-0.05624		
0.050	-0.38516	-0.16433	-0.38516	-0.04894		
0.060	-0.37695	-0.16918	-0.37695	-0.04338		
0.070	-0.36873	-0.17345	-0.36873	-0.04040		
0.080	-0.36052	-0.17723	-0.36052	-0.03591		
0.090	-0.35230	-0.18061	-0.35230	-0.03362		
0.100	-0.34409	-0.18363	-0.34409	-0.03109		
0.125	-0.32355	-0.18985	-0.32355	-0.02559		
0.150	-0.30301	-0.19452	-0.30301	-0.02169		
0.175	-0.28247	-0.19827	-0.28247	-0.01886		
0.200	-0.26193	-0.20120	-0.26193	-0.01587		
0.225	-0.24139	-0.20329	-0.24139	-0.01267		
0.250	-0.22065	-0.20454	-0.22065	-0.00925		
0.275	-0.20032	-0.20491	-0.20032	-0.00526		
0.300	-0.17976	-0.20438	-0.17976	-0.00161		
0.325	-0.15924	-0.20295	-0.15924	0.00262		
0.350	-0.13870	-0.20058	-0.13870	0.00714		
0.375	-0.11816	-0.19727	-0.11816	0.01199		
0.400	-0.09762	-0.19298	-0.09762	0.01720		
0.425	-0.07708	-0.18768	-0.07708	0.02278		
0.450	-0.05655	-0.18135	-0.05655	0.02877		
0.475	-0.03601	-0.17397	-0.03601	0.03518		
0.500	-0.01547	-0.16549	-0.01547	0.04209		
0.525	0.00507	-0.15587	0.00507	0.04949		
0.550	0.02561	-0.14509	0.02561	0.05747		
0.575	0.04615	-0.13308	0.04615	0.06505		
0.600	0.06669	-0.111982	0.06669	0.07531		
0.625	0.08722	-0.10523	0.08722	0.08529		
0.650	0.10776	-0.08927	0.10776	0.09006		
0.675	0.12830	-0.07189	0.12830	0.10775		
0.700	0.14884	-0.05300	0.14884	0.12839		
0.725	0.16938	-0.03255	0.16938	0.13612		
0.750	0.18992	-0.01042	0.18992	0.14906		
0.775	0.21046	0.01347	0.21046	0.16335		
0.800	0.23100	0.03921	0.23100	0.18315		
0.825	0.25153	0.06697	0.25153	0.20245		
0.850	0.27207	0.09688	0.27207	0.22409		
0.875	0.29261	0.12913	0.29261	0.24771		
0.900	0.31315	0.16396	0.31315	0.27581		
0.910	0.32137	0.17868	0.32137	0.28503		
0.920	0.32958	0.19387	0.32958	0.29671		
0.930	0.33780	0.20956	0.33780	0.30890		
0.940	0.34601	0.22576	0.34601	0.32160		
0.950	0.35423	0.24257	0.35423	0.33484		
0.960	0.36244	0.25996	0.36244	0.34864		
0.970	0.37066	0.27800	0.37066	0.36300	0.35610	
0.980	0.37887	0.29675	0.37887	0.37790	0.35756	
0.990	0.38709	0.31629	0.38709	0.39328	0.35491	
1.000	0.39530	0.33670	0.34004	0.40899	0.34004	

NO. 1 COR. INTOUR
TO 0 .D REV. 0 PART NO.
SUBTITLE L.E. ROOT

TITLE - SSMN FT FINAL IV...R.J.RONEY...6-
END NO. DATE 08/19/87 TIME 11:10:56
HOT RADIUS = 4.07250 CYLINDRICAL
COLD RADIUS = 4.02591 THERMAL SHRINK FACTOR = 1.00000

PRETMIST NOT USED FOR TO PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.34460	-0.12372	-0.10725	-0.34460	-0.08929	-0.10725
0.010	-0.33960	-0.12572	-0.12190	-0.33960	-0.08780	-0.09259
0.020	-0.33459	-0.12764	-0.12672	-0.33459	-0.08633	-0.08777
0.030	-0.32958	-0.12948	-0.12946	-0.32958	-0.08489	-0.08503
0.040	-0.32458	-0.13123	-0.13123	-0.32458	-0.08349	
0.050	-0.31957	-0.13289	-0.13289	-0.31957	-0.08215	
0.060	-0.31457	-0.13445	-0.13445	-0.31457	-0.08090	
0.070	-0.30956	-0.13591	-0.13591	-0.30956	-0.07974	
0.080	-0.30455	-0.13726	-0.13726	-0.30455	-0.07866	
0.090	-0.29955	-0.13856	-0.13856	-0.29955	-0.07766	
0.100	-0.29454	-0.13975	-0.13975	-0.29454	-0.07675	
0.125	-0.28203	-0.14235	-0.14235	-0.28203	-0.07476	
0.150	-0.26951	-0.14444	-0.14444	-0.26951	-0.07312	
0.175	-0.25700	-0.14612	-0.14612	-0.25700	-0.07156	
0.200	-0.24448	-0.14746	-0.14746	-0.24448	-0.06986	
0.225	-0.23197	-0.14853	-0.14853	-0.23197	-0.06796	
0.250	-0.21945	-0.14925	-0.14925	-0.21945	-0.06591	
0.275	-0.20694	-0.14962	-0.14962	-0.20694	-0.06376	
0.300	-0.19442	-0.14961	-0.14961	-0.19442	-0.06157	
0.325	-0.18191	-0.14921	-0.14921	-0.18191	-0.05929	
0.350	-0.16939	-0.14962	-0.14962	-0.16939	-0.05694	
0.375	-0.15688	-0.14722	-0.14722	-0.15688	-0.05451	
0.400	-0.14436	-0.14564	-0.14564	-0.14436	-0.05195	
0.425	-0.13186	-0.14366	-0.14366	-0.13186	-0.04929	
0.450	-0.11933	-0.14127	-0.14127	-0.11933	-0.04652	
0.475	-0.10681	-0.13848	-0.13848	-0.10681	-0.04361	
0.500	-0.09430	-0.13526	-0.13526	-0.09430	-0.04059	
0.525	-0.08178	-0.13162	-0.13162	-0.08178	-0.03744	
0.550	-0.06927	-0.12755	-0.12755	-0.06927	-0.03415	
0.575	-0.05675	-0.12302	-0.12302	-0.05675	-0.03074	
0.600	-0.04424	-0.11806	-0.11806	-0.04424	-0.02717	
0.625	-0.03172	-0.11263	-0.11263	-0.03172	-0.02546	
0.650	-0.01921	-0.10675	-0.10675	-0.01921	-0.01958	
0.675	-0.00669	-0.10038	-0.10038	-0.00669	-0.01556	
0.700	0.00582	-0.09353	-0.09353	0.00582	-0.01335	
0.725	0.01834	-0.08620	-0.08620	0.01834	-0.00696	
0.750	0.03085	-0.07835	-0.07835	0.03085	-0.00239	
0.775	0.04337	-0.07001	-0.07001	0.04337	-0.00237	
0.800	0.05588	-0.06115	-0.06115	0.05588	-0.00235	
0.825	0.06840	-0.05176	-0.05176	0.06840	0.01253	
0.850	0.08091	-0.04181	-0.04181	0.08091	0.01795	
0.875	0.09343	-0.03133	-0.03133	0.09343	0.02360	
0.900	0.10594	-0.02026	-0.02026	0.10594	0.02950	
0.910	0.11095	-0.01566	-0.01566	0.11095	0.03193	
0.920	0.11595	-0.01098	-0.01098	0.11595	0.03441	
0.930	0.12096	-0.00620	-0.00620	0.12096	0.03692	
0.940	0.12597	-0.00133	-0.00133	0.12597	0.03947	
0.950	0.13097	0.00363	0.00363	0.13097	0.04207	
0.960	0.13598	0.00867	0.00867	0.13598	0.04471	
0.970	0.14098	0.01380	0.01380	0.14098	0.04681	
0.980	0.14599	0.01901	0.01901	0.14599	0.04683	
0.990	0.15100	0.02431	0.02431	0.15100	0.04459	
1.000	0.15600	0.02970	0.02970	0.15600	0.03459	

EXTERNAL TUR
TD 0,0 REV. 0 PART NO. EMD NO. DATE 08/19/87 TIME 11:10:56
SUBTITLE T.E. ROOT HOT RADIUS = 4.12000 COLD RADIUS = 4.07290 THERMAL SHRINK FACTOR = 1.00000

PRETHIS NOT USED FOR TD PRINTOUT.

PCT	X	TOP	Y	TOP	(CIRCLE)	X	BOT	Y	BOT	(CIRCLE)
0.0	-0.42624	-0.12707	-0.11342	-0.42624	-0.09777	-0.11342				
0.010	-0.41794	-0.14082	-0.14082	-0.41794	-0.0602	-0.0602				
0.020	-0.40964	-0.15172	-0.15172	-0.40964	-0.0512	-0.0512				
0.030	-0.40134	-0.15977	-0.15977	-0.40134	-0.0707	-0.0707				
0.040	-0.39304	-0.16629	-0.16629	-0.39304	-0.0555	-0.0555				
0.050	-0.38474	-0.17180	-0.17180	-0.38474	-0.0504	-0.0504				
0.060	-0.37644	-0.17656	-0.17656	-0.37644	-0.0526	-0.0526				
0.070	-0.36814	-0.18073	-0.18073	-0.36814	-0.0611	-0.0611				
0.080	-0.36084	-0.18441	-0.18441	-0.36084	-0.0243	-0.0243				
0.090	-0.35154	-0.18765	-0.18765	-0.35154	-0.03916	-0.03916				
0.100	-0.34324	-0.19059	-0.19059	-0.34324	-0.0625	-0.0625				
0.125	-0.32249	-0.19652	-0.19652	-0.32249	-0.0332	-0.0332				
0.150	-0.30176	-0.20087	-0.20087	-0.30176	-0.0601	-0.0601				
0.175	-0.28099	-0.20426	-0.20426	-0.28099	-0.0262	-0.0262				
0.200	-0.26024	-0.20686	-0.20686	-0.26024	-0.0906	-0.0906				
0.225	-0.23949	-0.20849	-0.20849	-0.23949	-0.0527	-0.0527				
0.250	-0.21874	-0.20962	-0.20962	-0.21874	-0.0124	-0.0124				
0.275	-0.19799	-0.20973	-0.20973	-0.19799	-0.0694	-0.0694				
0.300	-0.17724	-0.20897	-0.20897	-0.17724	-0.0237	-0.0237				
0.325	-0.15649	-0.20732	-0.20732	-0.15649	-0.0250	-0.0250				
0.350	-0.13574	-0.20475	-0.20475	-0.13574	-0.0767	-0.0767				
0.375	-0.11499	-0.20125	-0.20125	-0.11499	-0.0318	-0.0318				
0.400	-0.09424	-0.19677	-0.19677	-0.09424	0.01906	0.01906				
0.425	-0.07349	-0.19129	-0.19129	-0.07349	0.0532	0.0532				
0.450	-0.05274	-0.18476	-0.18476	-0.05274	0.0200	0.0200				
0.475	-0.03199	-0.17721	-0.17721	-0.03199	0.09112	0.09112				
0.500	-0.01124	-0.16853	-0.16853	-0.01124	0.0674	0.0674				
0.525	0.00951	-0.15870	-0.15870	0.00951	0.0487	0.0487				
0.550	0.03026	-0.14769	-0.14769	0.03026	0.0358	0.0358				
0.575	0.05101	-0.13543	-0.13543	0.05101	0.0290	0.0290				
0.600	0.07176	-0.12188	-0.12188	0.07176	0.0291	0.0291				
0.625	0.09251	-0.10697	-0.10697	0.09251	0.0365	0.0365				
0.650	0.11326	-0.09066	-0.09066	0.11326	0.10520	0.10520				
0.675	0.13401	-0.07283	-0.07283	0.13401	0.1765	0.1765				
0.700	0.15476	-0.05344	-0.05344	0.15476	0.1108	0.1108				
0.725	0.17551	-0.03260	-0.03260	0.17551	0.14561	0.14561				
0.750	0.19626	-0.00959	-0.00959	0.19626	0.18136	0.18136				
0.775	0.21701	0.01510	0.01510	0.21701	0.17848	0.17848				
0.800	0.23776	0.04178	0.04178	0.23776	0.19714	0.19714				
0.825	0.25851	0.07064	0.07064	0.25851	0.22754	0.22754				
0.850	0.27926	0.10185	0.10185	0.27926	0.23994	0.23994				
0.875	0.30001	0.13567	0.13567	0.30001	0.24462	0.24462				
0.900	0.32076	0.17243	0.17243	0.32076	0.29194	0.29194				
0.910	0.32906	0.18805	0.18805	0.32906	0.30371	0.30371				
0.920	0.33736	0.20426	0.20426	0.33736	0.31600	0.31600				
0.930	0.34566	0.22103	0.22103	0.34566	0.32886	0.32886				
0.940	0.35396	0.23843	0.23843	0.35396	0.34232	0.34232				
0.950	0.36226	0.25664	0.25664	0.36226	0.35643	0.35643				
0.960	0.37056	0.27555	0.27555	0.37056	0.37124	0.37124				
0.970	0.37886	0.29530	0.29530	0.37886	0.3681	0.3681				
0.980	0.38716	0.31596	0.31596	0.38716	0.40319	0.40319				
0.990	0.39546	0.33765	0.33765	0.39546	0.42046	0.42046				
1.000	0.40376	0.36047	0.36047	0.40376	0.43870	0.43870				

NO. 1 COK MINTOUR
TD 0 RD REV. O PART NO.
SUBTITLE T.E. ROOT

TITLE - SSME FT FINAL IV...R.J.RONEY...
END NO.
HOT RADIUS = 4.12000
COLD RADIUS = 4.07290
THERMAL SHRINK FACTOR = 1.00000

67...CANT MAG, MYG...
DATE 08/19/87 TIME 11:10:56
CYLINDRICAL

PRETWIST NOT USED FOR TD PRINTOUT.

PCT	X	TOP	Y	TOP	(CIRCLE)	X	BOT	Y	BOT	(CIRCLE)
0.0	-0.34404	-0.13105	-0.11332	-0.34404	-0.09524	-0.11332				
0.010	-0.33886	-0.13296	-0.12855	-0.33886	-0.09368	-0.09809				
0.020	-0.33369	-0.13478	-0.13358	-0.33369	-0.09177	-0.09307				
0.030	-0.32851	-0.13652	-0.13645	-0.32851	-0.09010	-0.09019				
0.040	-0.32333	-0.13816	-0.13816	-0.32333	-0.08849					
0.050	-0.31816	-0.13974		-0.31816	-0.08696					
0.060	-0.31298	-0.14120		-0.31298	-0.08553					
0.070	-0.30780	-0.14257		-0.30780	-0.08419					
0.080	-0.30262	-0.14384		-0.30262	-0.08295					
0.090	-0.29745	-0.14503		-0.29745	-0.08180					
0.100	-0.29227	-0.14612		-0.29227	-0.08073					
0.125	-0.27933	-0.14846		-0.27933	-0.07838					
0.150	-0.26639	-0.15030		-0.26639	-0.07631					
0.175	-0.25344	-0.15172		-0.25344	-0.07428					
0.200	-0.24050	-0.15281		-0.24050	-0.07209					
0.225	-0.22756	-0.15360		-0.22756	-0.06970					
0.250	-0.21462	-0.15466		-0.21462	-0.06715					
0.275	-0.20167	-0.15416		-0.20167	-0.06451					
0.300	-0.18873	-0.15387		-0.18873	-0.06179					
0.325	-0.17579	-0.15318		-0.17579	-0.05899					
0.350	-0.16285	-0.15209		-0.16285	-0.05610					
0.375	-0.14990	-0.15059		-0.14990	-0.05311					
0.400	-0.13696	-0.14867		-0.13696	-0.04999					
0.425	-0.12402	-0.14634		-0.12402	-0.04675					
0.450	-0.11108	-0.14358		-0.11108	-0.04339					
0.475	-0.09813	-0.14039		-0.09813	-0.03988					
0.500	-0.08519	-0.13675		-0.08519	-0.03624					
0.525	-0.07225	-0.13265		-0.07225	-0.03246					
0.550	-0.05931	-0.12809		-0.05931	-0.02853					
0.575	-0.04636	-0.12504		-0.04636	-0.02445					
0.600	-0.03342	-0.11751		-0.03342	-0.02021					
0.625	-0.02048	-0.11147		-0.02048	-0.01580					
0.650	-0.00754	-0.10492		-0.00754	-0.01121					
0.675	0.00541	-0.09763		0.00541	-0.00645					
0.700	0.01835	-0.09021		0.01835	-0.00149					
0.725	0.03129	-0.08203		0.03129	0.00367					
0.750	0.04423	-0.07327		0.04423	0.00904					
0.775	0.05716	-0.06393		0.05716	0.01463					
0.800	0.07012	-0.05398		0.07012	0.02045					
0.825	0.08306	-0.04341		0.08306	0.02651					
0.850	0.09600	-0.03216		0.09600	0.03283					
0.875	0.10895	-0.02030		0.10895	0.03942					
0.900	0.12189	-0.00772		0.12189	0.04629					
0.910	0.12707	-0.00249		0.12707	0.04912					
0.920	0.13224	0.00265		0.13224	0.05200					
0.930	0.13742	0.00831		0.13742	0.05492					
0.940	0.14260	0.01389		0.14260	0.05790					
0.950	0.14777	0.01959		0.14777	0.06092					
0.960	0.15295	0.02540		0.15295	0.06400					
0.970	0.15813	0.03133		0.15813	0.06648					
0.980	0.16331	0.03740		0.16331	0.06667					
0.990	0.16848	0.04359		0.16848	0.06449					
1.000	0.17366	0.04992	0.05436	0.17366	0.07690	0.05436				

EXTERNAL TOUR
TD 0 TD REV.
SUBTITLE 1/4 ROOT

TITLE - SSME FT FINAL IV...R.J.ROHEY...6
END NO.
HOT RADIUS = 4.35975

PRETRUST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.42624	-0.16431	-0.14936	-0.42624	-0.13546	-0.16926
0.010	-0.41751	-0.17833	-0.17830	-0.41751	-0.12041	
0.020	-0.40879	-0.18932		-0.40879	-0.10836	
0.030	-0.40007	-0.19732		-0.40007	-0.09932	
0.040	-0.39134	-0.20369		-0.39134	-0.09191	
0.050	-0.38262	-0.20898		-0.38262	-0.08557	
0.060	-0.37389	-0.21349		-0.37389	-0.08001	
0.070	-0.36517	-0.21737		-0.36517	-0.07508	
0.080	-0.35644	-0.22075		-0.35644	-0.07067	
0.090	-0.34772	-0.22368		-0.34772	-0.06668	
0.100	-0.33899	-0.22624		-0.33899	-0.06309	
0.125	-0.31718	-0.23120		-0.31718	-0.05551	
0.150	-0.29537	-0.23446		-0.29537	-0.04943	
0.175	-0.27355	-0.23659		-0.27355	-0.04618	
0.200	-0.25174	-0.23802		-0.25174	-0.03847	
0.225	-0.22993	-0.23874		-0.22993	-0.03246	
0.250	-0.20812	-0.23871		-0.20812	-0.02616	
0.275	-0.18630	-0.23790		-0.18630	-0.01955	
0.300	-0.16449	-0.23628		-0.16449	-0.01260	
0.325	-0.14268	-0.23383		-0.14268	-0.00531	
0.350	-0.12087	-0.23051		-0.12087	0.00235	
0.375	-0.09905	-0.22628		-0.09905	0.01039	
0.400	-0.07724	-0.22110		-0.07724	0.01884	
0.425	-0.05543	-0.21493		-0.05543	0.02774	
0.450	-0.03362	-0.20772		-0.03362	0.03709	
0.475	-0.01180	-0.19943		-0.01180	0.04694	INLET ANGLE (DEG.)
0.500	0.01001	-0.19001		0.01001	0.05731	INLET WEDGE ANGLE (DEG.)
0.525	0.03182	-0.17939		0.03182	0.06824	EXIT ANGLE (DEG.)
0.550	0.05363	-0.16750		0.05363	0.07979	EXIT WEDGE ANGLE (DEG.)
0.575	0.07545	-0.15427		0.07545	0.09199	UNCOVERED TURNING ANGLE (DEG.)
0.600	0.09726	-0.13964		0.09726	0.10490	AXIAL CHORD
0.625	0.11907	-0.12349		0.11907	0.11859	ACTUAL CHORD
0.650	0.14088	-0.10574		0.14088	0.13311	PITCH
0.675	0.16270	-0.08628		0.16270	0.14855	NO. OF FOILS
0.700	0.18451	-0.06496		0.18451	0.16502	52
0.725	0.20632	-0.04166		0.20632	0.18262	
0.750	0.22813	-0.01619		0.22813	0.20169	
0.775	0.24995	0.01164		0.24995	0.22179	
0.800	0.27176	0.04205		0.27176	0.24372	
0.825	0.29357	0.07533		0.29357	0.26753	
0.850	0.31538	0.11185		0.31538	0.29354	
0.875	0.33720	0.15210		0.33720	0.32220	
0.900	0.35901	0.19676		0.35901	0.35407	
0.910	0.36773	0.21605		0.36773	0.36791	
0.920	0.37646	0.23628		0.37646	0.38247	
0.930	0.38518	0.25751		0.38518	0.39784	
0.940	0.39391	0.27985		0.39391	0.41413	
0.950	0.40263	0.30340		0.40263	0.43149	
0.960	0.41136	0.32829		0.41136	0.45010	
0.970	0.42008	0.35466		0.42008	0.47022	0.46169
0.980	0.42881	0.38267		0.42881	0.49220	0.46408
0.990	0.43753	0.41252		0.43753	0.51662	0.46177
1.000	0.44626	0.44443	0.44670	0.44626	0.54446	0.44670

CYLINDRICAL
THERMAL SHRINK FACTOR = 1.00000

DATE 08/19/87 TIME 11:10:56
COLD RADIUS = 4.30910

67..CANT MSG, MSG.:.

NO. 1 COR. INTOUR
TD 0 TD REV. O PART NO.
SUBTITLE 1/4 ROOT

TITLE - SSME FT FINAL IV...R.J.RONEY...6-
END NO.
HOT RADIUS = 4.35875

CYLINDRICAL
COLD RADIUS = 4.30910
THERMAL SHRINK FACTOR = 1.00000

PRETMIST NOT USED FOR TD PRINTOUT.

PCT	X	TOP	Y	TOP	(CIRCLE)	X	BOT	Y	BOT	(CIRCLE)
0.0	-0.34115	-0.16791	-0.14450	-0.34115	-0.12505	-0.14450				
0.010	-0.33521	-0.16950	-0.16242	-0.33521	-0.12227	-0.12658				
0.020	-0.32926	-0.17103	-0.16841	-0.32926	-0.11962	-0.12060				
0.030	-0.32332	-0.17267	-0.17191	-0.32332	-0.11706	-0.11709				
0.040	-0.31737	-0.17394		-0.31737	-0.11468					
0.050	-0.31143	-0.17510		-0.31143	-0.11241					
0.060	-0.30549	-0.17626		-0.30549	-0.11028					
0.070	-0.29954	-0.17732		-0.29954	-0.10826					
0.080	-0.29359	-0.17827		-0.29359	-0.10642					
0.090	-0.28764	-0.17913		-0.28764	-0.10468					
0.100	-0.28170	-0.17998		-0.28170	-0.10303					
0.125	-0.26686	-0.18154		-0.26686	-0.09923					
0.150	-0.25197	-0.18226		-0.25197	-0.09561					
0.175	-0.23711	-0.18274		-0.23711	-0.09182					
0.200	-0.22225	-0.18286		-0.22225	-0.08775					
0.225	-0.20738	-0.18270		-0.20738	-0.08345					
0.250	-0.19252	-0.18218		-0.19252	-0.07998					
0.275	-0.17766	-0.18125		-0.17766	-0.07440					
0.300	-0.16279	-0.17948		-0.16279	-0.06970					
0.325	-0.14793	-0.17807		-0.14793	-0.06486					
0.350	-0.13307	-0.17580		-0.13307	-0.05986					
0.375	-0.11820	-0.17305		-0.11820	-0.05472					
0.400	-0.10334	-0.16983		-0.10334	-0.04939					
0.425	-0.08847	-0.16609		-0.08847	-0.04367					
0.450	-0.07361	-0.16185		-0.07361	-0.03819					
0.475	-0.05875	-0.15706		-0.05875	-0.03231					
0.500	-0.04388	-0.15172		-0.04388	-0.02624					
0.525	-0.02902	-0.14578		-0.02902	-0.01996					
0.550	-0.01416	-0.13924		-0.01416	-0.01347					
0.575	0.00071	-0.13298		0.00071	-0.00677					
0.600	0.01557	-0.12425		0.01557	0.00017					
0.625	0.03043	-0.11573		0.03043	0.00735					
0.650	0.04530	-0.10650		0.04530	0.01479					
0.675	0.06016	-0.09652		0.06016	0.02248					
0.700	0.07502	-0.08575		0.07502	0.03045					
0.725	0.08989	-0.07416		0.08989	0.03871					
0.750	0.10476	-0.06171		0.10475	0.04726					
0.775	0.11961	-0.04834		0.11961	0.05616					
0.800	0.13443	-0.03398		0.13443	0.06539					
0.825	0.14934	-0.01861		0.14934	0.07497					
0.850	0.16420	-0.00216		0.16420	0.08493					
0.875	0.17907	0.01541		0.17907	0.09528					
0.900	0.19393	0.03416		0.19393	0.10605					
0.910	0.19989	0.04200		0.19988	0.11048					
0.920	0.20582	0.05006		0.20582	0.11499					
0.930	0.21177	0.05833		0.21177	0.11958					
0.940	0.21771	0.06685		0.21771	0.12425					
0.950	0.22366	0.07561		0.22366	0.12901					
0.960	0.22960	0.08464		0.22960	0.13386					
0.970	0.23555	0.09394		0.23555	0.13881					
0.980	0.24149	0.10355		0.24149	0.13949					
0.990	0.24744	0.11347		0.24744	0.14901					
1.000	0.25338	0.12371	0.12703	0.25338	0.15427	0.12703				

EXTERNAL : OUR
 TD : 0 TD REV. 0 PART NO.
 SUBTITLE MEAN

TITLE - SSME FT FINAL IV...R.J.RONEY...6-
 END NO.
 HOT RADIUS = 4.59750

J7...CANT HSG, HYG..
 DATE 08/19/87 TIME 11:10:56
 CYLINDRICAL

COLD RADIUS = 4.54530
 THERMAL SHRINK FACTOR = 1.00000

PRETMIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.42624	-0.19899	-0.18319	-0.42624	-0.16868	-0.18319
0.010	-0.41709	-0.21363	-0.21358	-0.41709	-0.15277	
0.020	-0.40794	-0.22509		-0.40794	-0.14002	
0.030	-0.39879	-0.23340		-0.39879	-0.13043	
0.040	-0.38964	-0.24001		-0.38964	-0.12255	
0.050	-0.38049	-0.24548		-0.38049	-0.11579	
0.060	-0.37134	-0.25013		-0.37134	-0.10986	
0.070	-0.36219	-0.25412		-0.36219	-0.10458	
0.080	-0.35304	-0.25758		-0.35304	-0.09955	
0.090	-0.34389	-0.26057		-0.34389	-0.09557	
0.100	-0.33474	-0.26317		-0.33474	-0.09170	
0.125	-0.31187	-0.26817		-0.31187	-0.08550	
0.150	-0.28899	-0.27137		-0.28899	-0.07708	
0.175	-0.26612	-0.27335		-0.26612	-0.07102	
0.200	-0.24324	-0.27461		-0.24324	-0.06665	
0.225	-0.22037	-0.27515		-0.22037	-0.05794	
0.250	-0.19749	-0.27692		-0.19749	-0.05089	
0.275	-0.17462	-0.27390		-0.17462	-0.04348	
0.300	-0.15174	-0.27207		-0.15174	-0.03570	
0.325	-0.12887	-0.26940		-0.12887	-0.02733	
0.350	-0.10599	-0.26586		-0.10599	-0.01895	
0.375	-0.08312	-0.26139		-0.08312	-0.00994	
0.400	-0.06024	-0.25598		-0.06024	-0.00050	
0.425	-0.03737	-0.24957		-0.03737	0.00942	
0.450	-0.01449	-0.24212		-0.01449	0.01983	
0.475	0.00838	-0.23357		0.00838	0.03077	INLET ANGLE (DEG.) 91.889
0.500	0.03126	-0.22387		0.03126	0.04225	INLET MEDGE ANGLE (DEG.) 112.055
0.525	0.05413	-0.21296		0.05413	0.05433	EXIT ANGLE (DEG.) 18.767
0.550	0.07701	-0.20076		0.07701	0.06703	EXIT MEDGE ANGLE (DEG.) 9.094
0.575	0.09986	-0.18718		0.09988	0.08040	UNCOVERED TURNING ANGLE (DEG.) 19.933
0.600	0.12276	-0.17215		0.12276	0.09450	AXIAL CHORD 0.91500
0.625	0.14563	-0.15556		0.14563	0.10938	ACTUAL CHORD 1.13218
0.650	0.16851	-0.13729		0.16851	0.12510	PITCH 0.55552
0.675	0.19138	-0.111720		0.19138	0.14174	NO. OF FOILS 52
0.700	0.21426	-0.09514		0.21426	0.15941	
0.725	0.23713	-0.07093		0.23713	0.17820	
0.750	0.26001	-0.04435		0.26001	0.19825	
0.775	0.28288	-0.01513		0.28288	0.21972	
0.800	0.30576	0.01704		0.30576	0.24282	
0.825	0.32863	0.05255		0.32863	0.26781	
0.850	0.35151	0.09190		0.35151	0.29502	
0.875	0.37438	0.13568		0.37438	0.32494	
0.900	0.39726	0.18464		0.39726	0.35823	
0.910	0.40641	0.20588		0.40641	0.37270	
0.920	0.41556	0.22818		0.41556	0.38796	
0.930	0.42471	0.25162		0.42471	0.40411	
0.940	0.43366	0.27629		0.43366	0.42129	
0.950	0.44301	0.30230		0.44301	0.43968	
0.960	0.45216	0.32977		0.45216	0.45952	
0.970	0.46131	0.35883		0.46131	0.48113	0.47393
0.980	0.47046	0.38965		0.47046	0.50500	0.47701
0.990	0.47961	0.42241		0.47961	0.53188	0.47491
1.000	0.48876	0.45734	0.45953	0.48876	0.56305	0.45933

NO. 1 COH CONTOUR
TD 0 TD REV.
SUBTITLE MEAN

TITLE - SSME FT FINAL IV...R.J.ROMEY...6 -87...CANT MMG, MMG...
END NO. DATE 08/19/87 TIME 11:10:56
HOT RADIUS = 4.59750 COLD RADIUS = 4.54530 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.33814	-0.20475	-0.17711	-0.33814	-0.15465	-0.17711
0.010	-0.33161	-0.20644	-0.19746	-0.33161	-0.15150	-0.15676
0.020	-0.32508	-0.20904	-0.20436	-0.32508	-0.14949	-0.14985
0.030	-0.31854	-0.20956	-0.20851	-0.31854	-0.14564	-0.14570
0.040	-0.31201	-0.21098	-0.21094	-0.31201	-0.14294	
0.050	-0.30548	-0.21230	-0.20548	-0.30548	-0.14039	
0.060	-0.29895	-0.21350	-0.29895	-0.18000	-0.13800	
0.070	-0.29242	-0.21457	-0.29242	-0.13576	-0.17711	0.03497
0.080	-0.28588	-0.21554	-0.28588	-0.13368	0.14486	0.01253
0.090	-0.27935	-0.21639	-0.27935	-0.13172		
0.100	-0.27282	-0.21713	-0.27282	-0.12988	-0.31021	-0.21136
0.125	-0.25649	-0.21849	-0.25649	-0.12560	-0.31669	-0.14486
0.150	-0.24016	-0.21927	-0.24016	-0.12145	0.31366	0.13911
0.175	-0.22383	-0.21956	-0.22383	-0.11704	0.29415	0.15416
0.200	-0.20750	-0.21947	-0.20750	-0.11228		
0.225	-0.19117	-0.21902	-0.19117	-0.10725	-0.33798	-0.18049
0.250	-0.17484	-0.21817	-0.17484	-0.10203	0.31018	0.15478
0.275	-0.15851	-0.21687	-0.15851	-0.09668		
0.300	-0.14218	-0.21508	-0.14218	-0.09119		
0.325	-0.12585	-0.21279	-0.12585	-0.08552		
0.350	-0.10952	-0.21000	-0.10952	-0.07966		
0.375	-0.09319	-0.20668	-0.09319	-0.07358		
0.400	-0.07686	-0.20264	-0.07686	-0.06729		
0.425	-0.06053	-0.19843	-0.06053	-0.06078		
0.450	-0.04420	-0.19345	-0.04420	-0.05406		
0.475	-0.02787	-0.18787	-0.02787	-0.04712		
0.500	-0.01154	-0.18166	-0.01154	-0.03994		
0.525	0.00479	-0.17480	0.00479	-0.03252		
0.550	0.02112	-0.16725	0.02112	-0.02484		
0.575	0.03745	-0.15900	0.03745	-0.01690		
0.600	0.05378	-0.15000	0.05378	-0.00869		
0.625	0.07011	-0.14022	0.07011	-0.00019		
0.650	0.08644	-0.12962	0.08644	0.00861		
0.675	0.10277	-0.11816	0.10277	0.01772		
0.700	0.11910	-0.10579	0.11910	0.02715		
0.725	0.13543	-0.09246	0.13543	0.03692		
0.750	0.15176	-0.07810	0.15176	0.04706		
0.775	0.16809	-0.06266	0.16809	0.05757		
0.800	0.18442	-0.04604	0.18442	0.06848		
0.825	0.20075	-0.02817	0.20075	0.07981		
0.850	0.21708	-0.00896	0.21708	0.09159		
0.875	0.23341	0.01166	0.23341	0.10383		
0.900	0.24974	0.03379	0.24974	0.11657		
0.910	0.25627	0.04310	0.25627	0.12181		
0.920	0.26280	0.05269	0.26280	0.12715		
0.930	0.26934	0.06258	0.26934	0.13258		
0.940	0.27587	0.07279	0.27587	0.13812		
0.950	0.28240	0.08334	0.28240	0.14376		
0.960	0.28893	0.09426	0.28893	0.14950		
0.970	0.29546	0.10552	0.29546	0.15535		
0.980	0.30200	0.11721	0.30200	0.16131		
0.990	0.30853	0.12931	0.30853	0.16740		
1.000	0.31506	0.14182	0.14486	0.17360		

EXTERNAL \ OUR
TD 0 TO REV. 0 PART NO.
SUBTITLE 1/4 TIP

TITLE - SSME FT FINAL 1V...R.J.ROMEY...6- J7...CANT MMG, MMG..:
END NO. DATE 08/19/87 TIME 11:10:56
HOT RADIUS = 4.83625 COLD RADIUS = 4.76150 THERMAL SHRINK FACTOR = 1.00000

PENTMIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.42264	-0.23137	-0.21513	-0.42624	-0.19968	-0.21513
0.010	-0.41667	-0.24695	-0.24693	-0.41667	-0.18332	
0.020	-0.40709	-0.25921		-0.40709	-0.17026	
0.030	-0.39751	-0.26817		-0.39751	-0.16051	
0.040	-0.38794	-0.27536		-0.38794	-0.15253	
0.050	-0.37837	-0.28136		-0.37837	-0.14574	
0.060	-0.36879	-0.28650		-0.36879	-0.13981	
0.070	-0.35922	-0.29096		-0.35922	-0.13456	
0.080	-0.34964	-0.29485		-0.34964	-0.12988	
0.090	-0.34007	-0.29826		-0.34007	-0.12567	
0.100	-0.33049	-0.30126		-0.33049	-0.12189	
0.125	-0.30555	-0.30719		-0.30555	-0.11399	
0.150	-0.28262	-0.31126		-0.28262	-0.10795	
0.175	-0.25868	-0.31408		-0.25868	-0.10258	
0.200	-0.23474	-0.31607		-0.23474	-0.09690	
0.225	-0.21080	-0.31722		-0.21080	-0.09083	
0.250	-0.18687	-0.31750		-0.18687	-0.08439	
0.275	-0.16233	-0.31692		-0.16293	-0.07755	
0.300	-0.13899	-0.31545		-0.13899	-0.07031	
0.325	-0.11505	-0.31308		-0.11505	-0.06264	
0.350	-0.09112	-0.30799		-0.09112	-0.05454	
0.375	-0.06718	-0.30553		-0.06718	-0.04598	
0.400	-0.04324	-0.30031		-0.04324	-0.03696	
0.425	-0.01930	-0.29406		-0.01930	-0.02745	
0.450	0.00463	-0.28676		0.00463	-0.01742	
0.475	0.02857	-0.27836		0.02857	-0.00685	
0.500	0.05251	-0.26891		0.05251	0.00427	
0.525	0.07448	-0.25807		0.07448	0.01600	
0.550	0.10038	-0.24604		0.10038	0.02835	
0.575	0.12332	-0.23367		0.12432	0.04137	
0.600	0.14826	-0.21787		0.14826	0.05511	
0.625	0.17220	-0.20153		0.17220	0.06962	
0.650	0.19613	-0.18355		0.19613	0.08496	
0.675	0.22007	-0.16776		0.22007	0.10119	
0.700	0.24401	-0.14202		0.24401	0.11841	
0.725	0.26795	-0.11812		0.26795	0.13671	
0.750	0.29188	-0.09181		0.29188	0.15621	
0.775	0.31582	-0.06277		0.31582	0.17706	
0.800	0.33397	-0.03060		0.33397	0.19945	
0.825	0.36370	0.00519		0.36370	0.22361	
0.850	0.38763	0.04517		0.38763	0.24985	
0.875	0.41157	0.08988		0.41157	0.27862	
0.900	0.43551	0.13992		0.43551	0.31051	
0.910	0.44509	0.16155		0.44508	0.32434	
0.920	0.45466	0.18417		0.45466	0.33890	
0.930	0.46623	0.20782		0.46623	0.35428	
0.940	0.47381	0.23253		0.47381	0.37060	
0.950	0.48338	0.25836		0.48338	0.38804	
0.960	0.49296	0.28538		0.49296	0.40680	
0.970	0.50253	0.31363		0.50253	0.42718	0.42284
0.980	0.51211	0.34319		0.51211	0.44961	0.42671
0.990	0.52168	0.37417		0.52168	0.47475	0.42483
1.000	0.53126	0.40667	0.40916	0.53126	0.50370	0.40916

NO. 1 CORU NTOUR TITLE - SSMF FT FINAL 1V...R.J.ROMEY...6-
 TD 0 10 REV. 0 PART NO. END NO. DATE 08/19/87 TIME 11:10:56
 SUBTITLE 1/4 TIP HOT RADIUS = 4.83625 COLD RADIUS = 4.76150 THERMAL SHRINK FACTOR = 1.00000

PRETHIST NOT USED FOR TD PRINTOUT.

PCT	X	TOP	Y	TOP	(CIRCLE)	X	BOT	Y	BOT	(CIRCLE)
0.0	-0.33501	-0.24150	-0.21122	-0.33501	-0.16405	-0.21122				
0.010	-0.32806	-0.24371	-0.23378	-0.32806	-0.18111	-0.18866				
0.020	0.32110	-0.24574	-0.24157	-0.32110	-0.17029	-0.18087				
0.030	-0.31415	-0.24766	-0.24638	-0.31415	-0.17560	-0.17605				
0.040	-0.30719	-0.24946	-0.24937	-0.30719	-0.17304	-0.17304				
0.050	-0.30023	-0.25114		-0.30023	-0.17063	-0.17063				
0.060	-0.29328	-0.25268		-0.29328	-0.16937	-0.16937				
0.070	-0.28632	-0.25408		-0.28632	-0.16627	-0.16627				
0.080	-0.27937	-0.25535		-0.27937	-0.16432	-0.16432				
0.090	-0.27241	-0.25649		-0.27241	-0.16250	-0.16250				
0.100	-0.26545	-0.25749		-0.26545	-0.16060	-0.16060				
0.125	-0.24806	-0.25947		-0.24806	-0.15689	-0.15689				
0.150	-0.23067	-0.26079		-0.23067	-0.15314	-0.15314				
0.175	-0.21328	-0.26156		-0.21328	-0.16914	-0.16914				
0.200	-0.19589	-0.26189		-0.19589	-0.16474	-0.16474				
0.225	-0.17850	-0.26179		-0.17850	-0.16003	-0.16003				
0.250	-0.16111	-0.26121		-0.16111	-0.15512	-0.15512				
0.275	-0.14372	-0.26012		-0.14372	-0.15006	-0.15006				
0.300	-0.12633	-0.25849		-0.12633	-0.14684	-0.14684				
0.325	-0.10894	-0.25631		-0.10894	-0.11941	-0.11941				
0.350	-0.09155	-0.25359		-0.09155	-0.11376	-0.11376				
0.375	-0.07416	-0.25031		-0.07416	-0.10787	-0.10787				
0.400	-0.05677	-0.24647		-0.05677	-0.10175	-0.10175				
0.425	-0.03938	-0.24202		-0.03938	-0.09536	-0.09536				
0.450	-0.02199	-0.23698		-0.02199	-0.08879	-0.08879				
0.475	-0.00460	-0.23132		-0.00460	-0.08195	-0.08195				
0.500	0.01279	-0.22501		0.01279	-0.07485	-0.07485				
0.525	0.03018	-0.21802		0.03018	-0.06748	-0.06748				
0.550	0.04757	-0.21033		0.04757	-0.05984	-0.05984				
0.575	0.06496	-0.20193		0.06496	-0.05193	-0.05193				
0.600	0.08235	-0.19276		0.08235	-0.04571	-0.04571				
0.625	0.09974	-0.18280		0.09974	-0.03619	-0.03619				
0.650	0.11713	-0.17200		0.11713	-0.02635	-0.02635				
0.675	0.13452	-0.16034		0.13452	-0.01719	-0.01719				
0.700	0.15191	-0.14774		0.15191	-0.00769	-0.00769				
0.725	0.16930	-0.13416		0.16930	0.00218	0.00218				
0.750	0.18669	-0.11952		0.18669	0.0243	0.0243				
0.775	0.20407	-0.10376		0.20407	0.0207	0.0207				
0.800	0.22146	-0.08678		0.22146	0.03413	0.03413				
0.825	0.23885	-0.06946		0.23885	0.04563	0.04563				
0.850	0.25624	-0.04871		0.25624	0.05760	0.05760				
0.875	0.27363	-0.02742		0.27363	0.07004	0.07004				
0.900	0.29102	-0.00439		0.29102	0.08303	0.08303				
0.910	0.29798	0.00536		0.29798	0.08838	0.08838				
0.920	0.30494	0.01543		0.30494	0.09382	0.09382				
0.930	0.31189	0.02586		0.31189	0.09937	0.09937				
0.940	0.31885	0.03666		0.31885	0.10501	0.10501				
0.950	0.32580	0.04785		0.32580	0.11076	0.11076				
0.960	0.33276	0.05947		0.33276	0.11662	0.11662				
0.970	0.33972	0.07145		0.33972	0.12257	0.12257				
0.980	0.34667	0.08390		0.34667	0.12862	0.12862				
0.990	0.35363	0.09679		0.35363	0.13476	0.12460				
1.000	0.36058	0.11012	0.11316	0.36058	0.14099	0.11316				

EXTERNAL .TOUR
TD 0 TD REV.
SUBTITLE T.E. TIP

TITLE - SSME FT FINAL IV...R.J.RONEY...6.
END NO.
HOT RADIUS = 5.07500
COLD RADIUS = 5.01770
THERMAL SHRINK FACTOR = 1.00000

CYLINDRICAL
TIME 11:10:56
DATE 08/19/87

PART NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.42624	-0.26280	-0.26628	-0.42624	-0.29777	-0.46628
0.010	-0.41624	-0.27945	-0.27945	-0.41624	-0.23112	-0.21312
0.020	-0.40624	-0.29265	-0.29265	-0.40624	-0.19992	
0.030	-0.39624	-0.30241	-0.30241	-0.39624	-0.19016	
0.040	-0.38624	-0.31031	-0.31031	-0.38624	-0.18225	
0.050	-0.37624	-0.31699	-0.31699	-0.37624	-0.15557	
0.060	-0.36624	-0.32277	-0.32277	-0.36624	-0.16980	
0.070	-0.35624	-0.32783	-0.32783	-0.35624	-0.16474	
0.080	-0.34624	-0.33251	-0.33251	-0.34624	-0.16026	
0.090	-0.33624	-0.33628	-0.33628	-0.33624	-0.15628	
0.100	-0.32624	-0.33982	-0.33982	-0.32624	-0.15276	
0.125	-0.30124	-0.34706	-0.34706	-0.30124	-0.15551	
0.150	0.27624	-0.35237	-0.35237	-0.27624	-0.16022	
0.175	-0.25124	-0.35645	-0.35645	-0.25124	-0.1609	
0.200	-0.22624	-0.35953	-0.35953	-0.22624	-0.16164	
0.225	-0.20124	-0.36161	-0.36161	-0.20124	-0.1624	
0.250	-0.17624	-0.36271	-0.36271	-0.17624	-0.16150	
0.300	-0.12624	-0.36195	-0.36195	-0.12624	-0.16579	
0.325	-0.10124	-0.36009	-0.36009	-0.10124	-0.16065	
0.350	-0.07624	-0.35725	-0.35725	-0.07624	-0.0601	
0.375	-0.05124	-0.35339	-0.35339	-0.05124	-0.08448	
0.400	-0.02624	-0.34852	-0.34852	-0.02624	-0.09047	
0.425	-0.00124	-0.34260	-0.34260	-0.00124	-0.07195	
0.450	0.02376	-0.335562	-0.335562	0.02376	-0.02920	
0.475	0.04876	-0.32754	-0.32754	0.04876	-0.03331	
0.500	0.07376	-0.31832	-0.31832	0.07376	-0.04315	
0.525	0.09876	-0.30792	-0.30792	0.09876	-0.0239	
0.550	0.12376	-0.29628	-0.29628	0.12376	-0.02100	
0.575	0.14876	-0.28334	-0.28334	0.14876	-0.08996	
0.600	0.17376	-0.26902	-0.26902	0.17376	-0.03796	
0.625	0.19876	-0.25323	-0.25323	0.19876	0.0729	
0.650	0.22376	-0.23586	-0.23586	0.22376	0.03159	
0.675	0.24876	-0.21676	-0.21676	0.24876	0.04675	
0.700	0.27376	-0.19577	-0.19577	0.27376	0.0284	
0.725	0.29876	-0.17264	-0.17264	0.29876	0.0795	
0.750	0.32376	-0.14721	-0.14721	0.32376	0.0919	
0.775	0.34876	-0.11899	-0.11899	0.34876	0.1768	
0.800	0.37376	-0.08755	-0.08755	0.37376	0.18558	
0.825	0.39876	-0.05223	-0.05223	0.39876	0.16109	
0.850	0.42376	-0.01260	-0.01260	0.42376	0.10548	
0.875	0.44876	0.03193	0.03193	0.44876	0.22110	
0.900	0.47376	0.08177	0.08177	0.47376	0.24144	
0.910	0.48376	0.10316	0.10316	0.48376	0.25410	
0.920	0.49376	0.12537	0.12537	0.49376	0.26738	
0.930	0.50376	0.14840	0.14840	0.50376	0.28334	
0.940	0.51376	0.17222	0.17222	0.51376	0.2609	
0.950	0.52376	0.19679	0.19679	0.52376	0.31176	
0.960	0.53376	0.22210	0.22210	0.53376	0.38550	
0.970	0.54376	0.24809	0.24809	0.54376	0.36453	0.34509
0.980	0.55376	0.27473	0.27473	0.55376	0.36115	0.35016
0.990	0.56376	0.30199	0.30199	0.56376	0.38781	0.34865
1.000	0.57376	0.32982	0.33284	0.57376	0.41224	0.33284

NO. 1 CON CONTOUR
TD 0 TD REV. 0 PART NO.
SUBTITLE T.E. TIP

TITLE - SSME FT FINAL 1V...R.J.RONEY...
END NO.
HOT RADIUS = 5.07500 COLD RADIUS = 5.01770 THERMAL SHRINK FACTOR = 1.00000

67...CANT HGS. HYG.
DATE 08/19/87 TIME 11:10:56
CYLINDRICAL

PRETRANS NOT USED FOR PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.33184	-0.27840	-0.24622	-0.33184	-0.21337	-0.24622
0.010	-0.32453	-0.28113	-0.27081	-0.32453	-0.21088	-0.22162
0.020	-0.31721	-0.28373	-0.27743	-0.31721	-0.20847	-0.21300
0.030	-0.30990	-0.28618	-0.28487	-0.30990	-0.20615	-0.20756
0.040	-0.30259	-0.28849	-0.28839	-0.30259	-0.20392	-0.20404
0.050	-0.29527	-0.29065	-0.29527	-0.29527	-0.20181	
0.060	-0.28796	-0.29266	-0.28796	-0.28796	-0.19986	
0.070	-0.28065	-0.29451	-0.28065	-0.28065	-0.19803	
0.080	-0.27334	-0.29621	-0.27334	-0.27334	-0.19635	
0.090	-0.26602	-0.29775	-0.26602	-0.26602	-0.19481	
0.100	-0.25871	-0.29914	-0.25871	-0.25871	-0.19339	
0.125	-0.24033	-0.30203	-0.24033	-0.24033	-0.19022	
0.150	-0.22216	-0.30416	-0.22215	-0.22215	-0.18725	
0.175	-0.20386	-0.30569	-0.20386	-0.20386	-0.18406	
0.200	-0.18558	-0.30671	-0.18558	-0.18558	-0.18046	
0.225	-0.16730	-0.30771	-0.16730	-0.16730	-0.17652	
0.250	-0.14902	-0.30716	-0.14902	-0.14902	-0.17235	
0.275	-0.13073	-0.30652	-0.13073	-0.13073	-0.16801	
0.300	-0.11245	-0.30529	-0.11245	-0.11245	-0.16349	
0.325	-0.09417	-0.30366	-0.09417	-0.09417	-0.15874	
0.350	-0.07589	-0.30105	-0.07589	-0.07589	-0.15375	
0.375	-0.05760	-0.29805	-0.05760	-0.05760	-0.14851	
0.400	-0.03932	-0.29446	-0.03932	-0.03932	-0.14302	
0.425	-0.02104	-0.29025	-0.02104	-0.02104	-0.13728	
0.450	-0.00276	-0.28543	-0.00276	-0.00276	-0.13128	
0.475	0.01553	-0.27938	0.01553	0.01553	-0.12502	
0.500	0.03581	-0.27387	0.03581	0.03581	-0.11849	
0.525	0.05209	-0.26709	0.05209	0.05209	-0.11168	
0.550	0.07037	-0.25963	0.07037	0.07037	-0.10459	
0.575	0.08866	-0.25145	0.08866	0.08866	-0.09720	
0.600	0.10694	-0.24253	0.10694	0.10694	-0.08951	
0.625	0.12522	-0.23284	0.12522	0.12522	-0.08150	
0.650	0.14350	-0.22233	0.14350	0.14350	-0.07316	
0.675	0.16179	-0.21098	0.16179	0.16179	-0.06452	
0.700	0.18007	-0.19872	0.18007	0.18007	-0.05551	
0.725	0.19835	-0.18550	0.19835	0.19835	-0.04613	
0.750	0.21663	-0.17123	0.21663	0.21663	-0.03637	
0.775	0.23492	-0.15588	0.23492	0.23492	-0.02621	
0.800	0.25320	-0.13932	0.25320	0.25320	-0.01563	
0.825	0.27148	-0.12162	0.27148	0.27148	-0.00462	
0.850	0.28976	-0.10203	0.28976	0.28976	-0.00685	
0.875	0.30805	-0.08103	0.30805	0.30805	0.01082	
0.900	0.32633	-0.05813	0.32633	0.32633	0.03134	
0.910	0.33364	-0.04837	0.33364	0.33364	0.03651	
0.920	0.34096	-0.03824	0.34096	0.34096	0.04177	
0.930	0.34827	-0.02772	0.34827	0.34827	0.04712	
0.940	0.35558	-0.01679	0.35558	0.35558	0.05257	
0.950	0.36289	-0.00544	0.36289	0.36289	0.05812	
0.960	0.37021	0.00635	0.37021	0.37021	0.06376	
0.970	0.37752	0.01858	0.37752	0.37752	0.06948	
0.980	0.38483	0.03124	0.38483	0.38483	0.07333	
0.990	0.39215	0.04435	0.39215	0.39215	0.07239	
1.000	0.39946	0.05791	0.06103	0.39946	0.08700	0.06103

EXTERNAL TOUR
TD 0 TD REV.
SUBTITLE L.E. TIP

TITLE - SAME FT FINAL IV...R.J.ROMEY...6
END NO.
HOT RADIUS = 5.20000
COLD RADIUS = 5.14137
TIME 11:10:56
DATE 08/19/87
THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.42624	-0.27929	-0.26263	-0.42624	-0.24556	-0.26263
0.010	-0.41602	-0.29650		-0.41602	-0.22875	-0.22876
0.020	-0.40579	-0.31016		-0.40579	-0.21547	
0.030	-0.39557	-0.32035		-0.39557	-0.20570	
0.040	-0.38535	-0.32862		-0.38535	-0.19782	
0.050	-0.37513	-0.33565		-0.37513	-0.19119	
0.060	-0.36490	-0.34176		-0.36490	-0.18550	
0.070	-0.35466	-0.34713		-0.35466	-0.18053	
0.080	-0.34446	-0.35191		-0.34446	-0.17615	
0.090	-0.33424	-0.35617		-0.33424	-0.17229	
0.100	-0.32402	-0.35999		-0.32402	-0.16887	
0.125	-0.29846	-0.36790		-0.29846	-0.16197	
0.150	-0.27290	-0.37385		-0.27290	-0.15706	
0.175	-0.24735	-0.37557		-0.24735	-0.15356	
0.200	-0.22179	-0.38221		-0.22179	-0.14974	
0.225	-0.19623	-0.38477		-0.19623	-0.14549	
0.250	-0.17066	-0.38626		-0.17066	-0.14079	
0.275	-0.14512	-0.38675		-0.14512	-0.13566	
0.300	-0.11957	-0.38616		-0.11957	-0.13007	
0.325	-0.09401	-0.38458		-0.09401	-0.12402	
0.350	-0.06865	-0.38197		-0.06865	-0.11750	
0.375	-0.04290	-0.37831		-0.04290	-0.11049	
0.400	-0.01734	-0.37362		-0.01734	-0.10299	
0.425	0.00822	-0.36786		0.00822	-0.09496	
0.450	0.03377	-0.36104		0.03377	-0.08640	
0.475	0.05933	-0.35312		0.05933	-0.07730	
0.500	0.08489	-0.34407		0.08489	-0.06762	
0.525	0.11044	-0.33384		0.11044	-0.05735	
0.550	0.13600	-0.32240		0.13600	-0.04644	
0.575	0.16155	-0.30968		0.16155	-0.03489	
0.600	0.18711	-0.29560		0.18711	-0.02263	
0.625	0.21267	-0.28008		0.21267	-0.00964	
0.650	0.23822	-0.26302		0.23822	0.00414	
0.675	0.26376	-0.24427		0.26376	0.01877	
0.700	0.28934	-0.22366		0.28934	0.03629	
0.725	0.31489	-0.20097		0.31489	0.05080	
0.750	0.34045	-0.17592		0.34045	0.06961	
0.775	0.36600	-0.14811		0.36600	0.08722	
0.800	0.39156	-0.11702		0.39156	0.10737	
0.825	0.41712	-0.08199		0.41712	0.12903	
0.850	0.44267	-0.04243		0.44267	0.15249	
0.875	0.46823	0.00212		0.46823	0.17803	
0.900	0.49379	0.05183		0.49379	0.20607	
0.910	0.50601	0.07311		0.50601	0.21814	
0.920	0.51423	0.09514		0.51423	0.23077	
0.930	0.52445	0.11788		0.52445	0.24402	
0.940	0.53466	0.14126		0.53466	0.25797	
0.950	0.54490	0.16521		0.54490	0.27274	
0.960	0.55512	0.18967		0.55512	0.28846	
0.970	0.56534	0.21454		0.56534	0.30689	
0.980	0.57556	0.23971		0.57556	0.32350	0.31092
0.990	0.58579	0.26509		0.58579	0.34340	0.30669
1.000	0.59601	0.29056	0.29390	0.59601	0.36556	0.23390

NO. 1 COA MNTOR
TD 0 ID REV.
SUBTITLE L.E. TIP

TITLE - SSME FT FINAL IV...R.J.RONEY...6-
O PART NO.
COLD RADIUS = 5.20000

END NO.
DATE 08/19/87 TIME 11:10:56
COLD RADIUS = 5.14137 THERMAL SHRINK FACTOR = 1.000000

PRETWIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.33016	-0.29768	-0.26461	-0.33016	-0.22872	-0.26461
0.010	-0.32268	-0.30072	-0.29025	-0.32268	-0.22646	-0.2897
0.020	-0.31518	-0.30360	-0.29928	-0.31518	-0.22426	-0.22994
0.030	-0.30767	-0.30633	-0.30503	-0.30767	-0.22212	-0.22419
0.040	-0.30017	-0.30890	-0.30881	-0.30017	-0.22005	-0.2041
0.050	-0.29267	-0.31131	-0.29267	-0.21810		
0.060	-0.28517	-0.31356	-0.28517	-0.21628		
0.070	-0.27766	-0.31565	-0.27766	-0.21460		
0.080	-0.27016	-0.31756	-0.27016	-0.21307		
0.090	-0.26266	-0.31931	-0.26266	-0.21167		
0.100	-0.25516	-0.32090	-0.25516	-0.21039		
0.125	-0.23640	-0.32425	-0.23640	-0.20759		
0.150	-0.21764	-0.32680	-0.21764	-0.20501		
0.175	-0.19889	-0.32872	-0.19889	-0.20224		
0.200	-0.18013	-0.33009	-0.18013	-0.19904		
0.225	-0.16138	-0.33089	-0.16138	-0.19548		
0.250	-0.14262	-0.33111	-0.14262	-0.19168		
0.275	-0.12386	-0.33069	-0.12386	-0.18771		
0.300	-0.10511	-0.32966	-0.10511	-0.18354		
0.325	-0.08635	-0.32801	-0.08635	-0.17913		
0.350	-0.06760	-0.32575	-0.06760	-0.17447		
0.375	-0.04884	-0.32289	-0.04884	-0.16955		
0.400	-0.03008	-0.31942	-0.03008	-0.16437		
0.425	-0.01133	-0.31533	-0.01133	-0.15894		
0.450	0.00743	-0.31061	0.00743	-0.15323		
0.475	0.02618	-0.30526	0.02618	-0.14726		
0.500	0.04694	-0.29925	0.04694	-0.14101		
0.525	0.06370	-0.29256	0.06370	-0.13447		
0.550	0.08245	-0.285520	0.08245	-0.12765		
0.575	0.10121	-0.27713	0.10121	-0.12052		
0.600	0.11996	-0.26832	0.11996	-0.11308		
0.625	0.15872	-0.25876	0.15872	-0.10532		
0.650	0.15748	-0.24838	0.15748	-0.09725		
0.675	0.17623	-0.23718	0.17623	-0.08884		
0.700	0.19499	-0.22507	0.19499	-0.08006		
0.725	0.21374	-0.21202	0.21374	-0.07091		
0.750	0.23250	-0.19793	0.23250	-0.06139		
0.775	0.25126	-0.18276	0.25126	-0.05146		
0.800	0.27001	-0.16639	0.27001	-0.04111		
0.825	0.28877	-0.14867	0.28877	-0.03033		
0.850	0.30753	-0.12944	0.30753	-0.01909		
0.875	0.32628	-0.10856	0.32628	-0.00735		
0.900	0.34504	-0.08569	0.34504	0.00496		
0.910	0.35254	-0.07591	0.35254	0.01004		
0.920	0.36004	-0.06573	0.36004	0.01521		
0.930	0.36754	-0.05515	0.36754	0.02048		
0.940	0.37505	-0.04413	0.37505	0.02583		
0.950	0.38255	-0.03267	0.38255	0.03129		
0.960	0.39005	-0.02076	0.39005	0.03683		
0.970	0.39755	-0.00840	0.39755	0.04245		
0.980	0.40506	0.00440	0.40506	0.04664		
0.990	0.41256	0.01765	0.41256	0.04589		
1.000	0.42006	0.03134	0.42006	0.03449		

P624 UTILITY PROGRAM - FLOW AREA CALCULATION

SSHE FT FINAL IV...R.J.RONEY...6-10-87...CANT HSS, NYC...

HOT	COLD
4.0230	4.02890
4.12000	4.07610
5.07500	5.02090
5.20000	5.14460
RETAGGER ANGLE	DEGREES = 0.0
PLATFORM RADI	LE ID = 0.0
	LE 00 = 0.0
GAGING RADII	TE ID = 0.0
	TE 00 = 0.0
	INNER = 4.111220
	OUTER = 5.08288
NUMBER OF VANES FOR GAGING = 52	
STAGGER IN DEGREES IS -3.00 TO 3.00 IN INCREMENTS OF .50	
IN CLASS IS - 6 TO 6	
TOLER = 0.0	

STAGGER (DEGREES)	HOT FLOW (SQ IN)	CHANGE FLOW AREA	COLD FLOW (SQ IN)	SHRINK
-3.00000	8.74233	-12.01953		
-2.50000	8.94340	-9.99530		
-2.00000	9.14361	-7.97917		
-1.50000	9.34330	-5.97158		
-1.00000	9.54196	-3.97235		
-0.50000	9.73976	-1.96175		
0.0	9.93666	0.0	9.72575	
0.50000	10.13276	1.97333		
1.00000	10.32795	3.93764		
1.50000	10.52226	5.89315		
2.00000	10.71569	7.83981		
2.50000	10.90823	9.77748		
3.00000	11.09986	11.70621		

MEANING DESIGN OF PPTIVE CLASS TEST - 9. 9/23/14

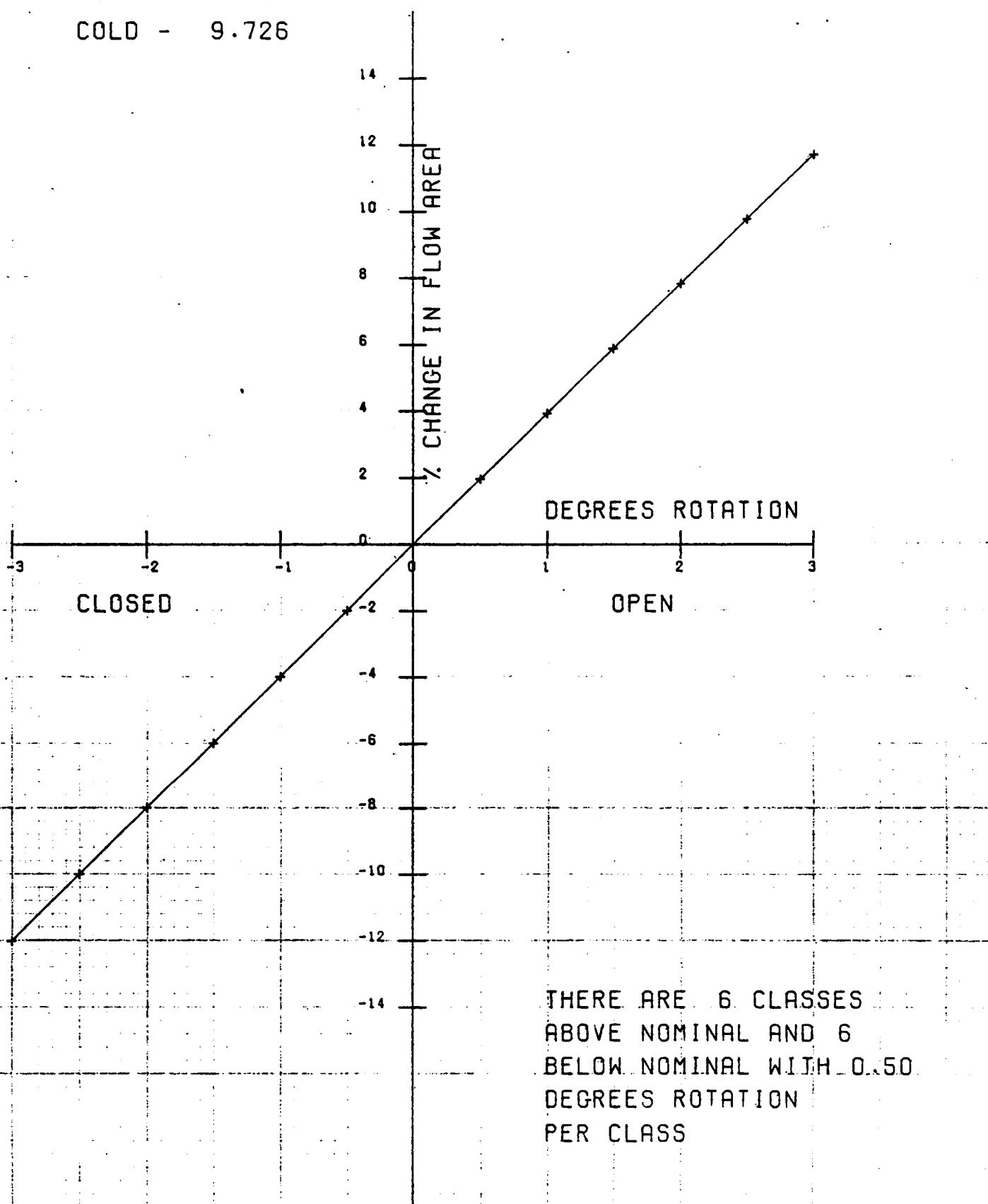
X-HO1 CHENGE DISTANCE (M)

SSME FT FINAL 1V...R.J.ROWEY...6-10-87...CANT MXG. MYG...

NOMINAL FLOW AREA - SQ. IN.

HOT - 9.937

COLD - 9.726



SSME FIT FINAL 1V...R.J.RONEY...6-10-87...CANT HOG, HIG...
 DENSITY = 0.31100 WEIGHTING RADIU INNER = 4.1065 OUTER = 5.1507
 SHROUD VOLUME = 0.0 SHROUD THICKNESS = 0.0
 SHROUD MISALIGNMENT = 0.0 RADIUS OF SHROUD = 0.0
 HEIGHT OF AIRFOIL = 0.03931 HEIGHT OF SHROUD = 0.0
 TOTAL HEIGHT = 2.04417 NUMBER OF VANES = 52

SUMMARY OF SECTION PROPERTIES

ZS	RADIUS	AREA	IMIN	IMAX	THETA	XBAR	YBAR
0	4.1065	0.1005	0.5211E-01	0.4612E-02	-28.31	-0.0027	0.0016
10	4.2109	0.1072	0.6250E-03	0.7928E-02	-31.08	0.0167	-0.0083
20	4.3153	0.1128	0.7231E-03	0.9177E-02	-32.93	0.0328	-0.0130
30	4.4198	0.1175	0.6131E-03	0.1030E-01	-33.99	0.0462	-0.0120
40	4.5242	0.1213	0.8933E-03	0.1125E-01	-34.37	0.0576	-0.0052
50	4.6286	0.1241	0.9622E-03	0.1199E-01	-34.10	0.0673	0.0075
60	4.7330	0.1261	0.1019E-02	0.1252E-01	-33.29	0.0754	0.0256
70	4.8374	0.1275	0.1068E-02	0.1289E-01	-32.98	0.0825	0.0474
80	4.9419	0.1286	0.1109E-02	0.1316E-01	-30.66	0.0898	0.0713
90	5.0463	0.1295	0.1149E-02	0.1342E-01	-29.18	0.0947	0.0957
100	5.1507	0.1305	0.1191E-02	0.1372E-01	-27.79	0.1005	0.1195

ZS	RADIUS	K	L	MAX T	AX.HDITH	C1	C2
0	4.1065	0.0	0.2605E-03	0.2083	0.8276	0.1302	0.1496
10	4.2109	0.0	0.3305E-03	0.2197	0.8462	0.1369	0.1566
20	4.3153	0.0	0.4221E-03	0.2326	0.8646	0.1423	0.1620
30	4.4198	0.0	0.5085E-03	0.2474	0.8839	0.1484	0.1661
40	4.5242	0.0	0.5873E-03	0.2632	0.9019	0.1497	0.1693
50	4.6286	0.0	0.6522E-03	0.2803	0.9205	0.1521	0.1718
60	4.7330	0.0	0.6990E-03	0.2985	0.9391	0.1538	0.1736
70	4.8374	0.0	0.7320E-03	0.3176	0.9577	0.1550	0.1751
80	4.9419	0.0	0.7567E-03	0.3373	0.9763	0.1580	0.1761
90	5.0463	0.0	0.7801E-03	0.3573	0.9949	0.1664	0.1770
100	5.1507	0.0	0.8073E-03	0.3771	1.0135	0.1570	0.1779

ZS	RADIUS	C3	C4	CTE	C4	ALPHA_B	B
0	4.1065	0.1430	0.3816	0.5104	0.0411	59.37	0.3499
10	4.2109	0.1504	0.4061	0.5344	0.0397	56.75	0.9987
20	4.3153	0.1574	0.4265	0.5564	0.0564	55.00	1.0416
30	4.4198	0.1636	0.4429	0.5749	0.0409	54.01	1.0772
40	4.5242	0.1692	0.4552	0.5892	0.0463	53.67	1.1048
50	4.6286	0.1737	0.4637	0.5990	0.0466	53.93	1.1241
60	4.7330	0.1771	0.4687	0.6047	0.0424	54.71	1.1361
70	4.8374	0.1796	0.4714	0.6078	0.0348	55.66	1.1433
80	4.9419	0.1816	0.4729	0.6097	0.0358	57.21	1.1492
90	5.0463	0.1835	0.4743	0.6119	0.0439	58.61	1.1532
100	5.1507	0.1852	0.4760	0.6150	0.0343	59.94	1.1595

SSME FT FINAL IV...R.J.RONEY...6-10-87..CANT HOG, NYG...
 DENSITY = 0.31100 WEIGHTING RADIU INNER = 4.1065 OUTER = 5.1507
 SHROUD VOLUME = 0.0 SHROUD THICKNESS = 0.0
 SHROUD MISALIGNMENT = 0.0 RADIUS OF SHROUD = 0.0
 WEIGHT OF AIRFOIL = 0.03932 HEIGHT OF SHROUD = 0.0
 TOTAL WEIGHT = 2.04443 NUMBER OF VANES = 52

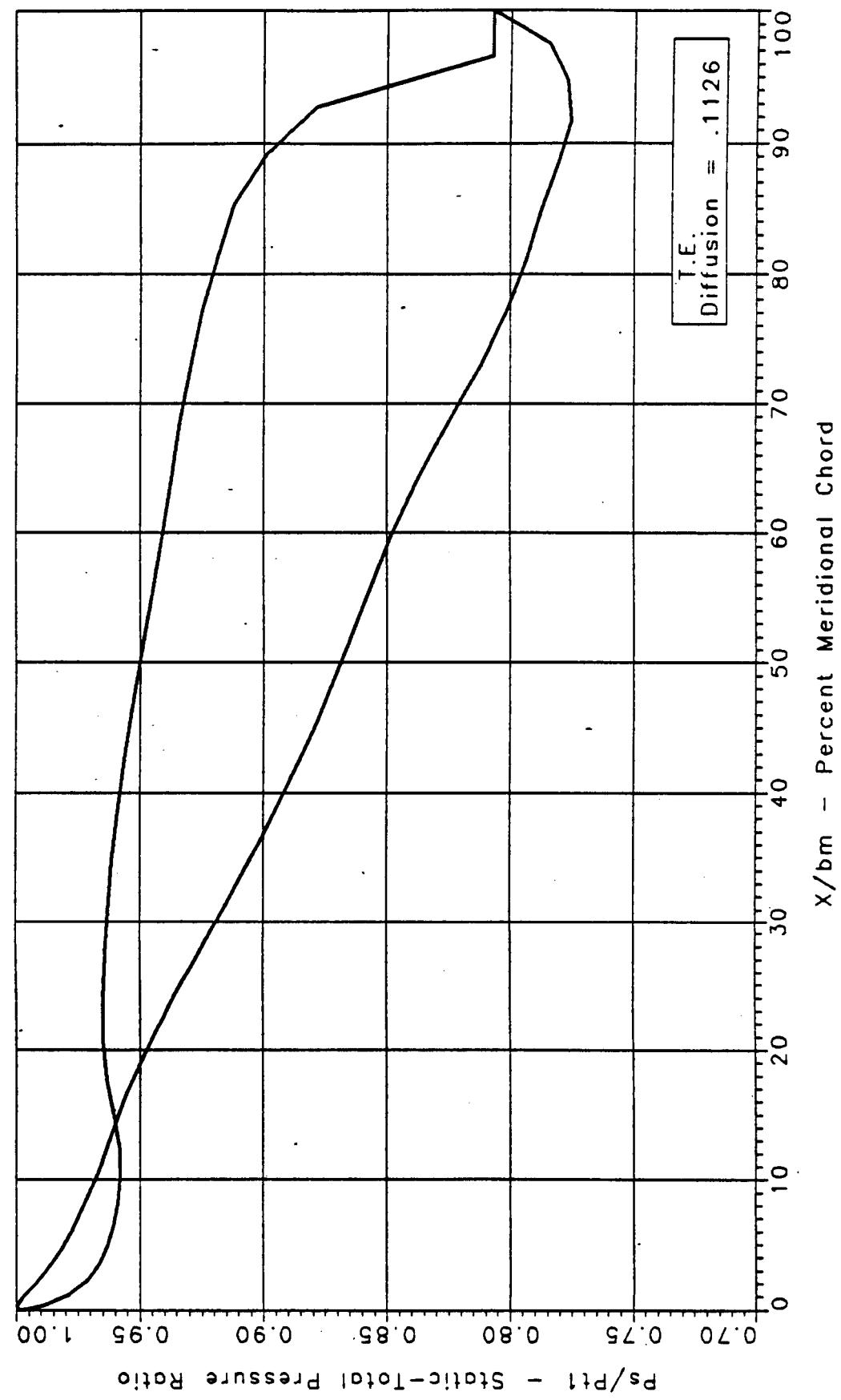
SUMMARY OF SECTION PROPERTIES

%S	RADIUS	I MIN	I MAX	THETA	XBAR	YBAR	YEAR	
0	4.1065	0.1005	0.5212E-03	0.6612E-02	-28.33	-0.0027	0.0016	
10	4.2109	0.1072	0.6251E-03	0.7928E-02	-31.06	0.0167	-0.0083	
20	4.3153	0.1129	0.7232E-03	0.9177E-02	-32.93	0.0328	-0.0129	
30	4.4198	0.1175	0.8132E-03	0.1030E-01	-33.99	0.0463	-0.0119	
40	4.5242	0.1213	0.8923E-03	0.1125E-01	-36.37	0.0577	-0.0051	
50	4.6286	0.1241	0.9622E-03	0.1199E-01	-34.10	0.0673	0.0076	
60	4.7330	0.1261	0.1019E-02	0.1252E-01	-33.29	0.0755	0.0256	
70	4.8374	0.1276	0.1068E-02	0.1289E-01	-32.06	0.0825	0.0475	
80	4.9419	0.1286	0.1110E-02	0.1314E-01	-30.46	0.0885	0.0714	
90	5.0463	0.1295	0.1149E-02	0.1342E-01	-29.18	0.0947	0.0958	
100	5.1507	0.1305	0.1191E-02	0.1372E-01	-27.79	0.1006	0.1195	
%S	RADIUS	C1	C2	C3	MAX T	AX. MEDIUM	C1	C2
0	4.1065	0.9890E-03	0.2605E-03	0.2062	0.8276	0.1302	0.1496	
10	4.2109	0.1200E-02	0.3886E-03	0.2197	0.8462	0.1369	0.1566	
20	4.3153	0.1409E-02	0.4230E-03	0.2329	0.8648	0.1423	0.1620	
30	4.4198	0.1609E-02	0.5084E-03	0.2674	0.8836	0.1484	0.1661	
40	4.5242	0.1797E-02	0.5875E-03	0.2632	0.9019	0.1497	0.1693	
50	4.6286	0.1962E-02	0.6523E-03	0.2803	0.9205	0.1521	0.1718	
60	4.7330	0.2106E-02	0.6993E-03	0.2985	0.9391	0.1538	0.1736	
70	4.8374	0.2232E-02	0.7324E-03	0.3176	0.9577	0.1550	0.1751	
80	4.9419	0.2355E-02	0.7572E-03	0.3373	0.9763	0.1558	0.1761	
90	5.0463	0.2456E-02	0.7806E-03	0.3573	0.9949	0.1564	0.1770	
100	5.1507	0.2572E-02	0.8076E-03	0.3772	0.1035	0.1571	0.1779	
%S	RADIUS	C3	C4	C5	C6	ALPHA S	B	
0	4.1065	0.1429	0.3815	0.5104	0.0411	59.37	0.9499	
10	4.2109	0.1504	0.4061	0.5344	0.0397	56.76	0.9987	
20	4.3153	0.1574	0.4265	0.5564	0.0563	55.00	1.0416	
30	4.4198	0.1636	0.4429	0.5749	0.0409	54.01	1.0772	
40	4.5242	0.1692	0.4552	0.5892	0.0463	53.67	1.1046	
50	4.6286	0.1737	0.4636	0.5990	0.0466	53.93	1.1241	
60	4.7330	0.1771	0.4686	0.6047	0.0423	54.71	1.1361	
70	4.8374	0.1796	0.4714	0.6076	0.0348	55.86	1.1433	
80	4.9419	0.1816	0.4729	0.6097	0.0357	57.21	1.1462	
90	5.0463	0.1834	0.4743	0.6119	0.0339	58.61	1.1532	
100	5.1507	0.1852	0.4760	0.6151	0.0343	59.94	1.1595	

SSME FT FINAL IV...R.J.RONEY...6-10-87...CANT HOG, HOG...
 OPERATING CONDITION 1 109 PCT...ADP...R.J.RONEY...6-10-87...
 MAE = 152.0 MM 2 0.0 1004.3 28.5 MDT 2 119.2

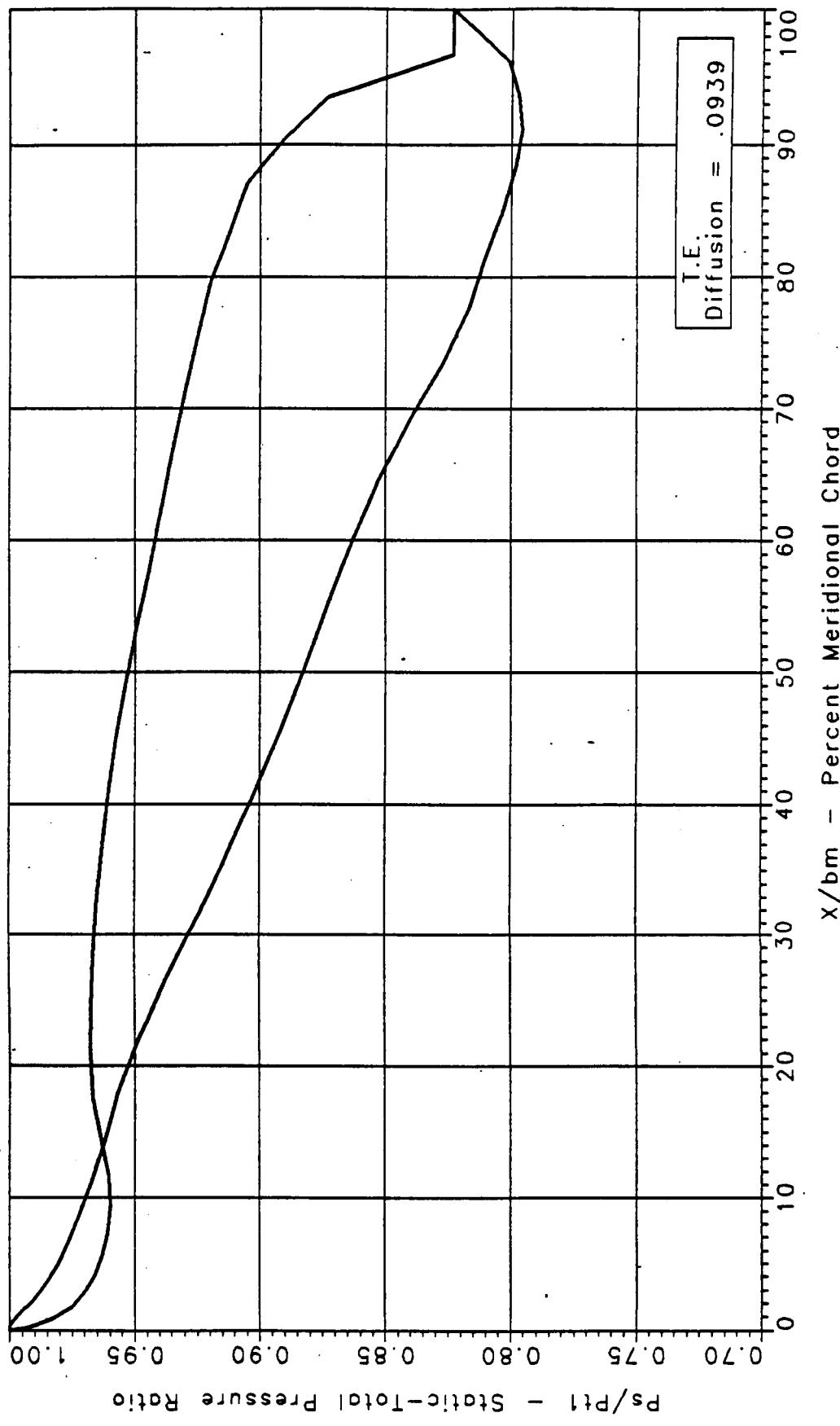
ZS	RADIUS	SIG P/A	SWRD P/A	LE	TE	CONV	NET BENDING		MVT = 350.2
							LE	TE	
0	4.1065	0.0	0.0	0.0	0.0	0.0	-2332.	-2332.	
10	4.2109	0.0	0.0	2785.	1399.	3545.	-5399.	-5399.	
20	4.3153	0.0	0.0	6096.	6216.	6216.	-8862.	-8862.	
30	4.4198	0.0	0.0	9796.	13833.	9188.	-12895.	-12895.	
40	4.5242	0.0	0.0	13833.	18196.	12361.	-17256.	-17256.	
50	4.6286	0.0	0.0	22892.	15646.	15646.	-21886.	-21886.	
60	4.7330	0.0	0.0	27895.	18977.	18977.	-26711.	-26711.	
70	4.8374	0.0	0.0	31175.	22236.	22236.	-32064.	-32064.	
80	4.9419	0.0	0.0	36657.	25562.	25562.	-37226.	-37226.	
90	5.0463	0.0	0.0	44268.	28755.	28755.	-42426.	-42426.	
100	5.1507	0.0	0.0						
ZS	RADIUS	SIG P/A	SWRD P/A	LE	TE	CONV	GAS BENDING		MVT = 350.2
							LE	TE	
0	4.1065	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	4.2109	0.0194	-0.0099	2785.	1399.	3545.	-2332.	-2332.	
20	4.3153	0.0355	-0.0146	6096.	6216.	6216.	-5399.	-5399.	
30	4.4198	0.0690	-0.0136	9796.	13833.	9188.	-12895.	-12895.	
40	4.5242	0.0904	-0.0068	13833.	18196.	12361.	-17256.	-17256.	
50	4.6286	0.0700	0.0059	22892.	15646.	15646.	-21886.	-21886.	
60	4.7330	0.0782	0.0240	27895.	18977.	18977.	-26711.	-26711.	
70	4.8374	0.0652	0.0458						
80	4.9419	0.0915	0.0997	33175.	22236.	22236.	-32064.	-32064.	
90	5.0463	0.0974	0.0941	38657.	25562.	25562.	-37226.	-37226.	
100	5.1507	0.1033	0.1179	44268.	28755.	28755.	-42426.	-42426.	
ZS	RADIUS	AREA	PULL	LE	TE	CONV	SURROUND MTS ALIGNMENT		MVT = 350.2
							LE	TE	
0	4.1065	0.1005	0.0	0.0	0.0	0.0	0.0	0.0	
10	4.2109	0.1072	0.0	0.0	0.0	0.0	0.0	0.0	
20	4.3153	0.1128	0.0	0.0	0.0	0.0	0.0	0.0	
30	4.4198	0.1175	0.0	0.0	0.0	0.0	0.0	0.0	
40	4.5242	0.1213	0.0	0.0	0.0	0.0	0.0	0.0	
50	4.6286	0.1241	0.0	0.0	0.0	0.0	0.0	0.0	
60	4.7330	0.1261	0.0	0.0	0.0	0.0	0.0	0.0	
70	4.8374	0.1275	0.0	0.0	0.0	0.0	0.0	0.0	
80	4.9419	0.1286	0.0	0.0	0.0	0.0	0.0	0.0	
90	5.0463	0.1295	0.0	0.0	0.0	0.0	0.0	0.0	
100	5.1507	0.1305	0.0	0.0	0.0	0.0	0.0	0.0	
ZS	RADIUS	PWT	MVT	PWS	MVT	THETA N	NET BENDING		MVT = 350.2
							LE	TE	
0	4.1065	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	4.2109	0.0	0.0	0.0	0.7	17.0	2.47	2.47	
20	4.3153	0.0	0.0	4.0	36.0	63.0	5.94	5.94	
30	4.4198	0.0	0.0	9.7	92.0	92.0	6.72	6.72	
40	4.5242	0.0	0.0	17.9	125.0	125.0	10.98	10.98	
50	4.6286	0.0	0.0	26.5	125.0	125.0	12.86	12.86	
60	4.7330	0.0	0.0	41.7	162.0	162.0	14.43	14.43	
70	4.8374	0.0	0.0	57.4	203.1	203.1	15.77	15.77	
80	4.9419	0.0	0.0	75.5	246.1	246.1	16.92	16.92	
90	5.0463	0.0	0.0	96.1	297.2	297.2	17.92	17.92	
100	5.1507	0.0	0.0	119.2	350.2	350.2	18.80	18.80	

PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution "C" - Mesh
Poisson Generated



PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution "C"-Mesh
Poisson Generated

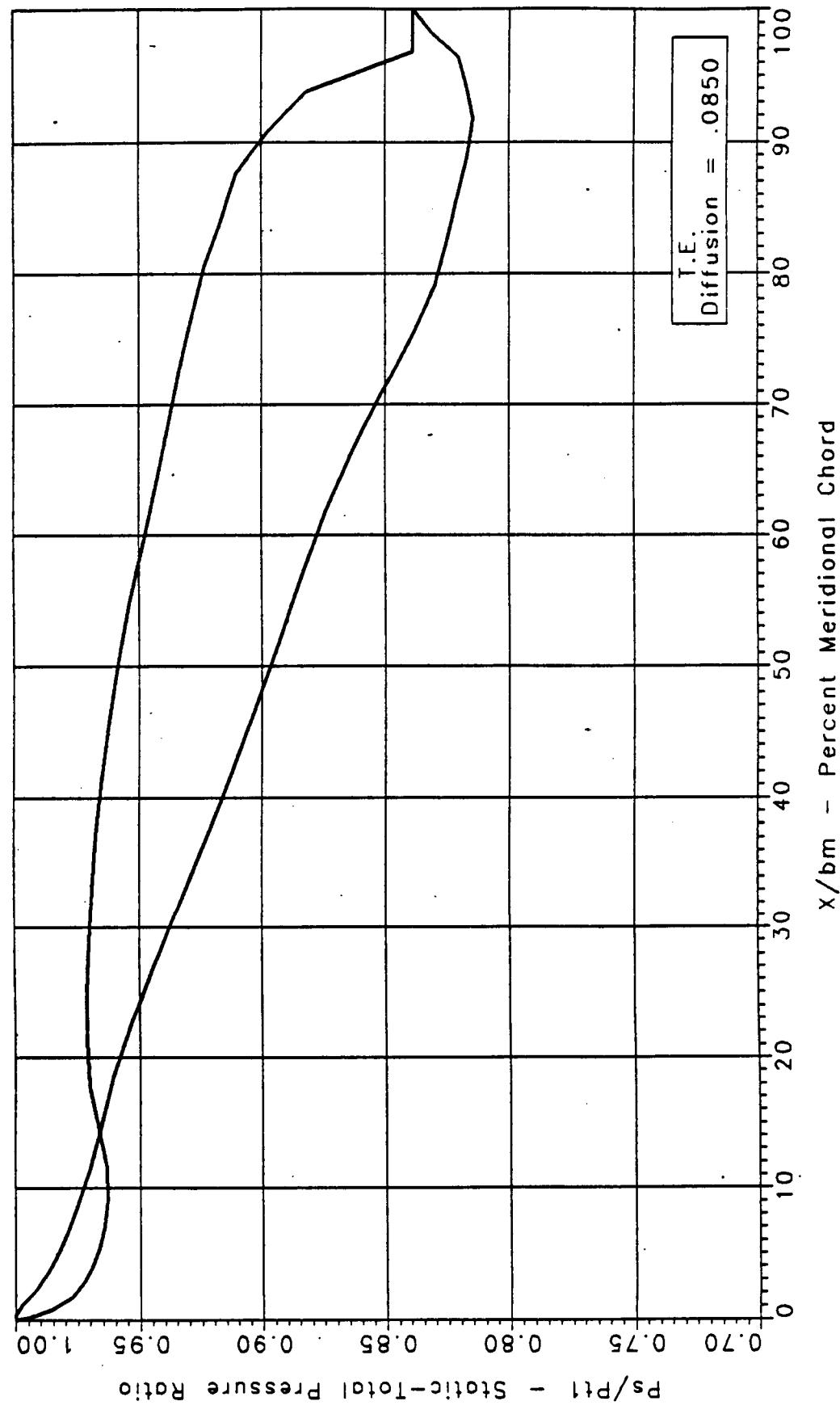
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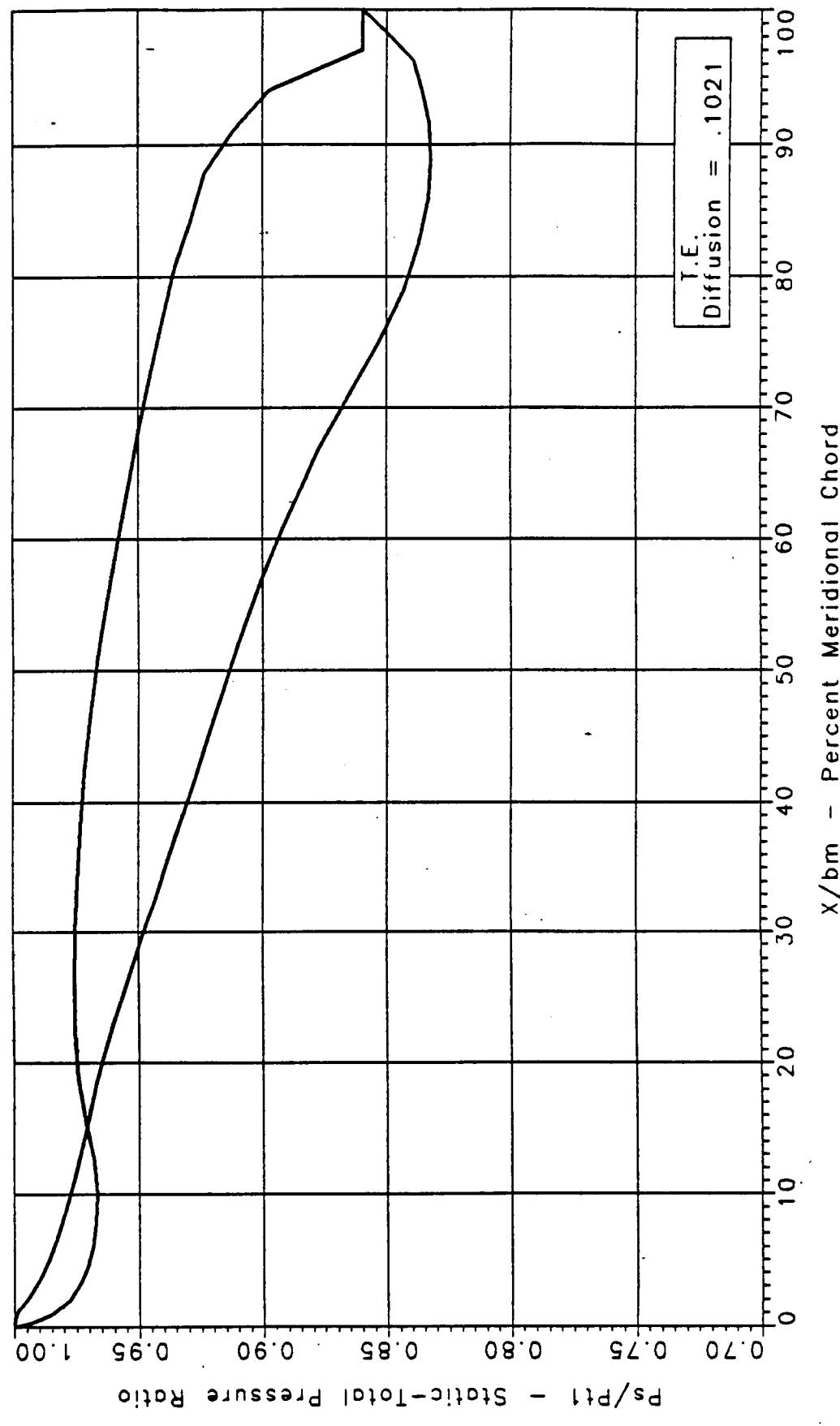
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PRATT & WHITNEY
SSME ATT Fuel Pump Turbine
3-D Pressure Distribution "C" - Mesh
Poisson Generated

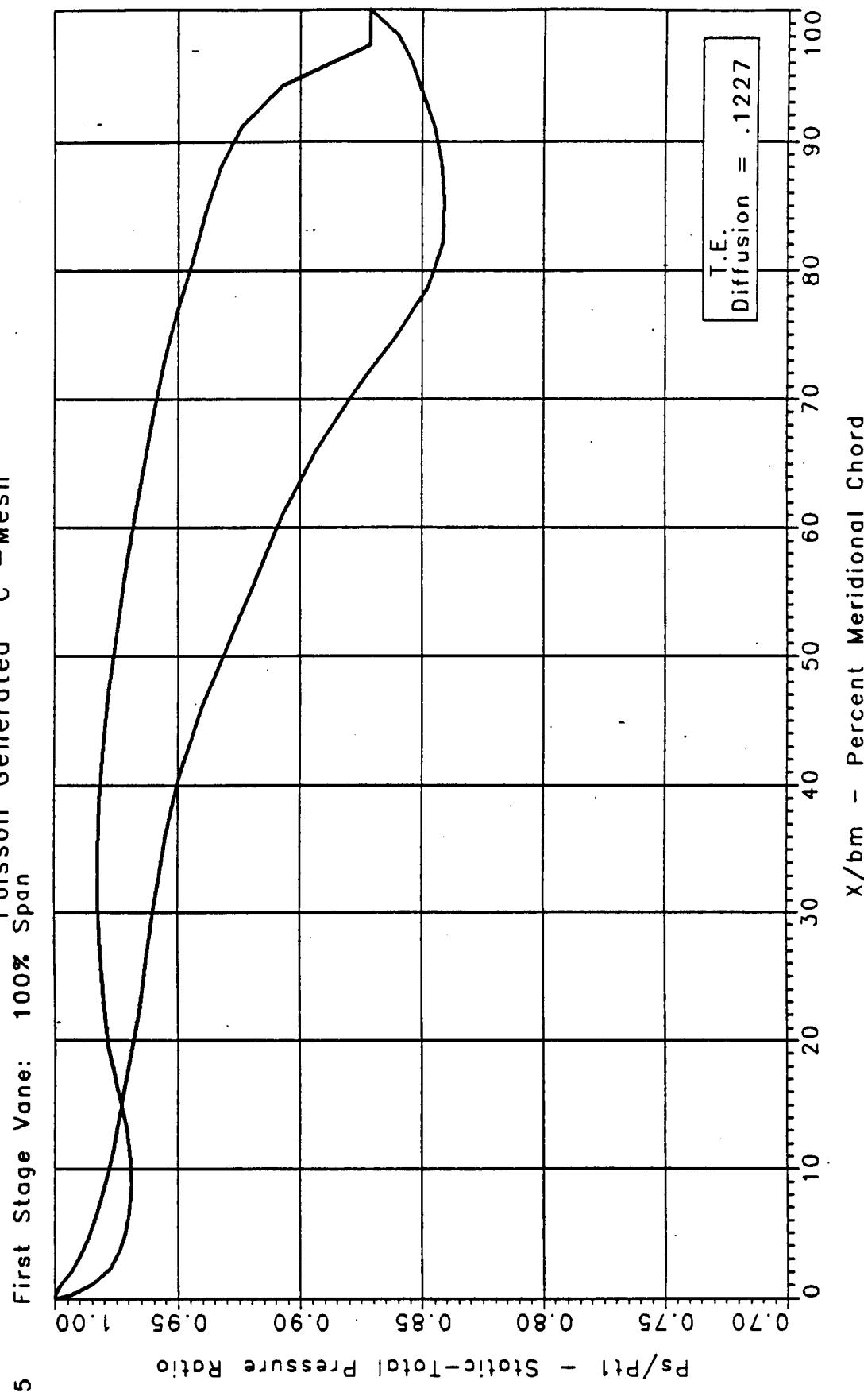
3 First Stage Vane: 50% Span



PRATT & WHITNEY
 SSME ATT Fuel Pump Turbine
 3-D Pressure Distribution "C" - Mesh
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 4 First Stage Vane: 75% Span

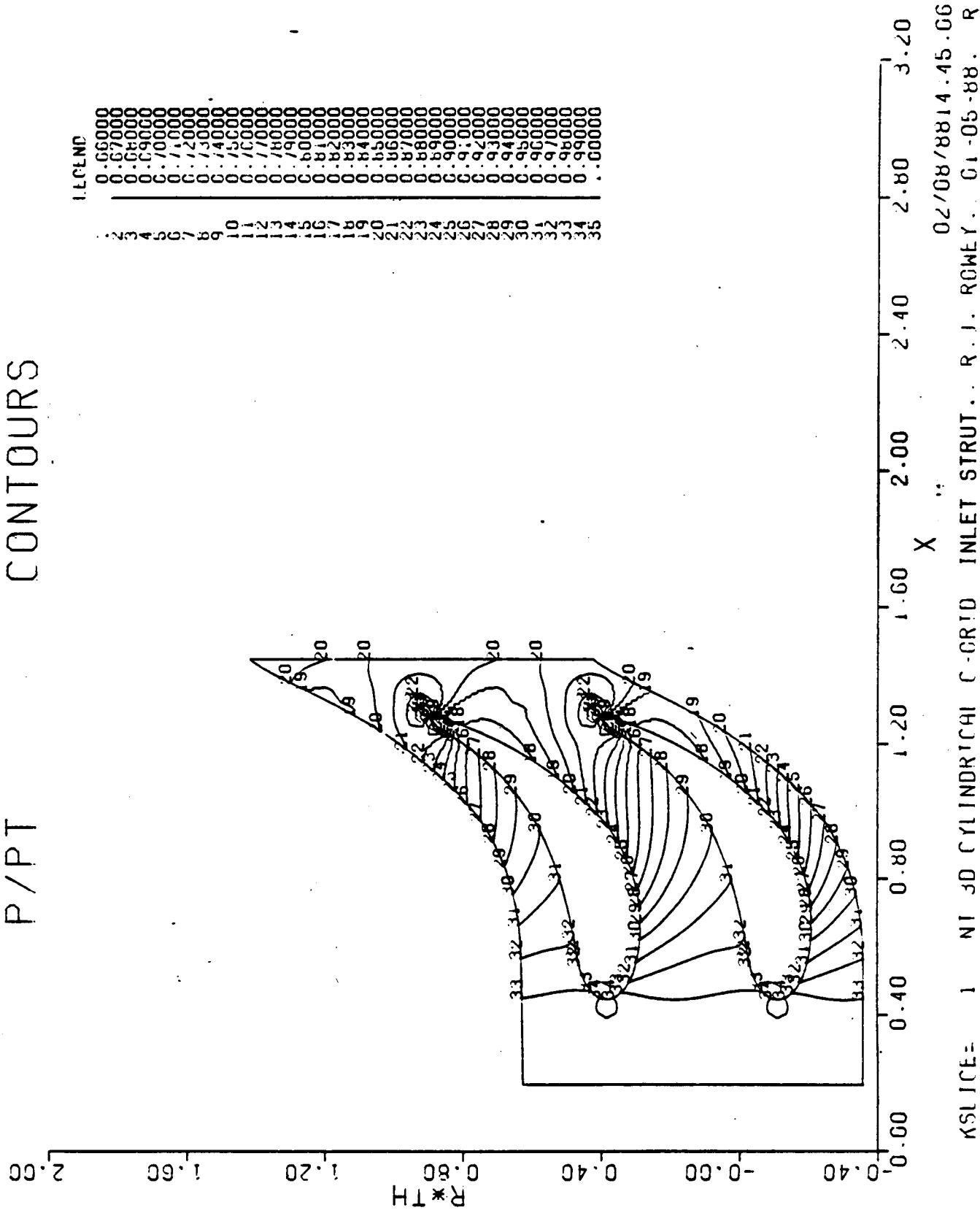


PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution (V310)
Poisson Generated "C" - Mesh



08/20/87
DLS

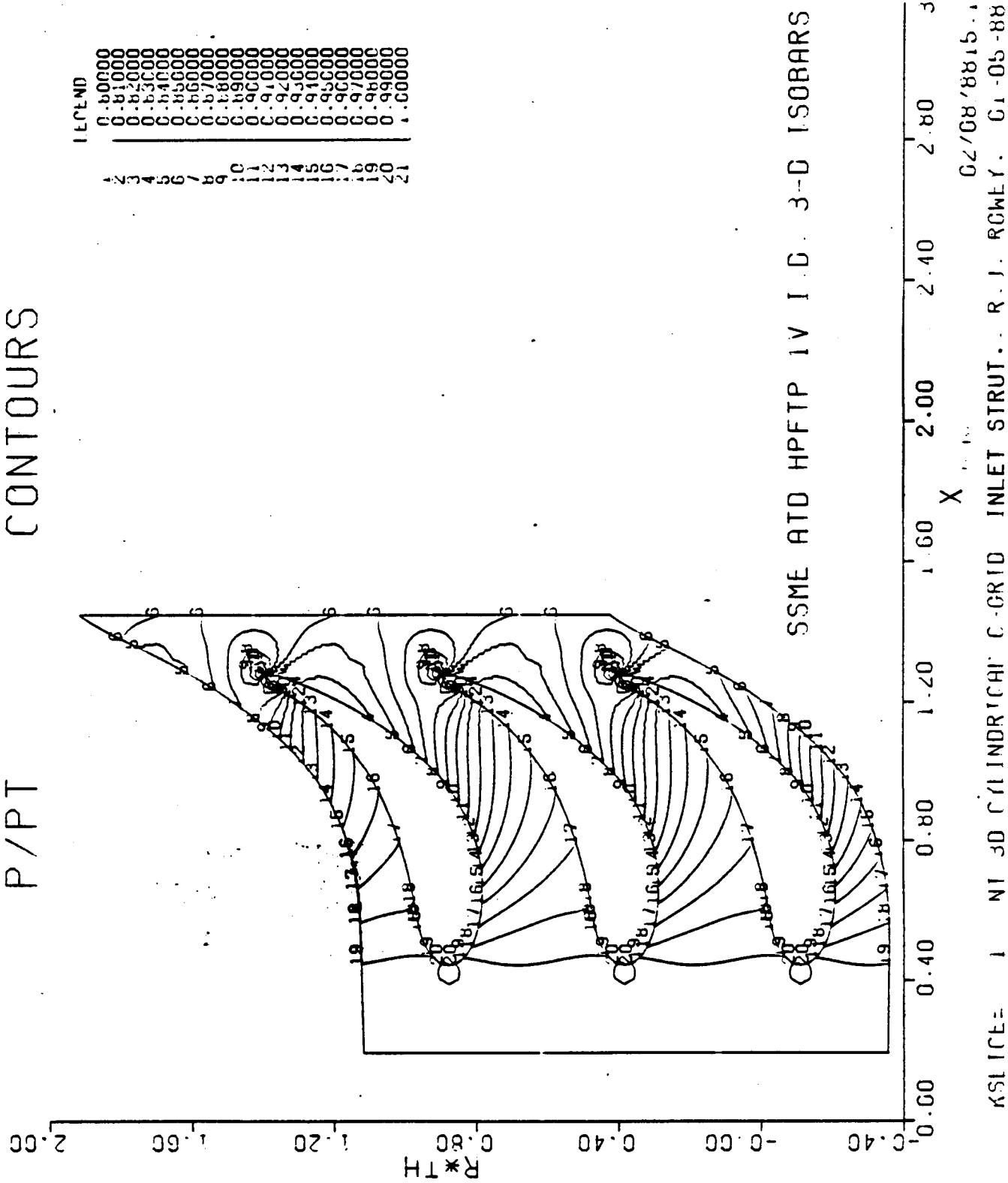
P / P T CONTOURS



P/P_T

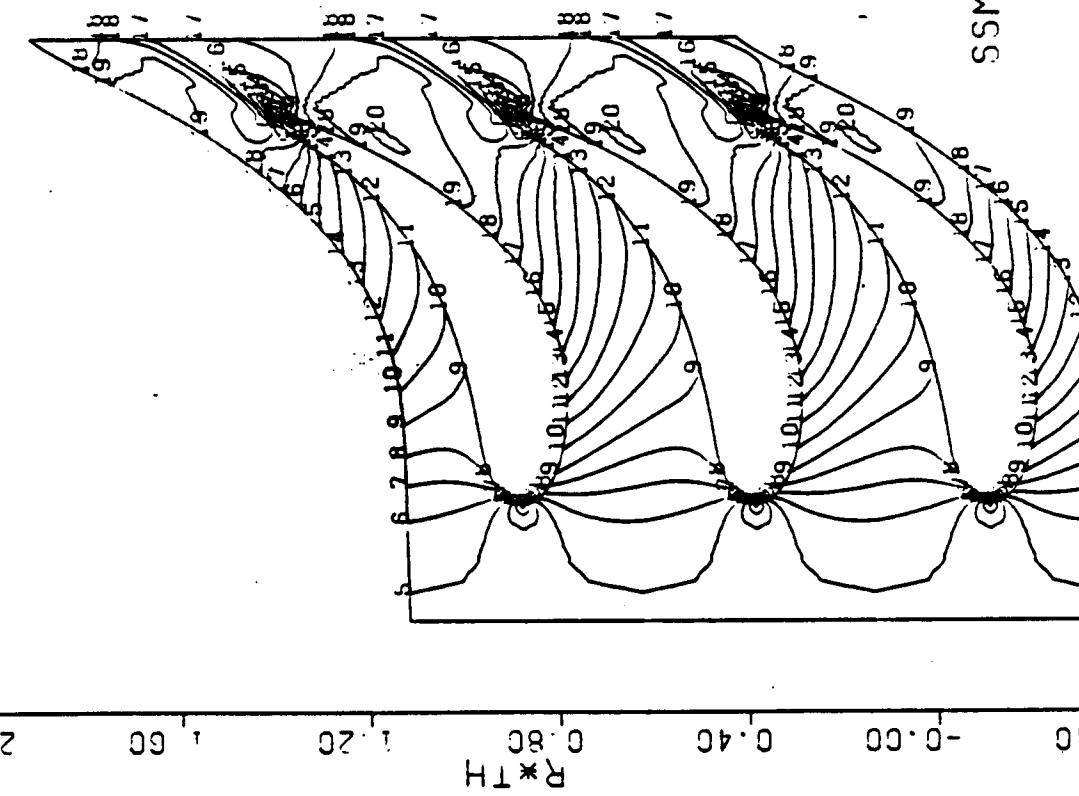
CONTOURS

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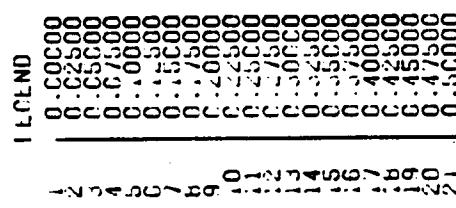


MACH

CONTOURS



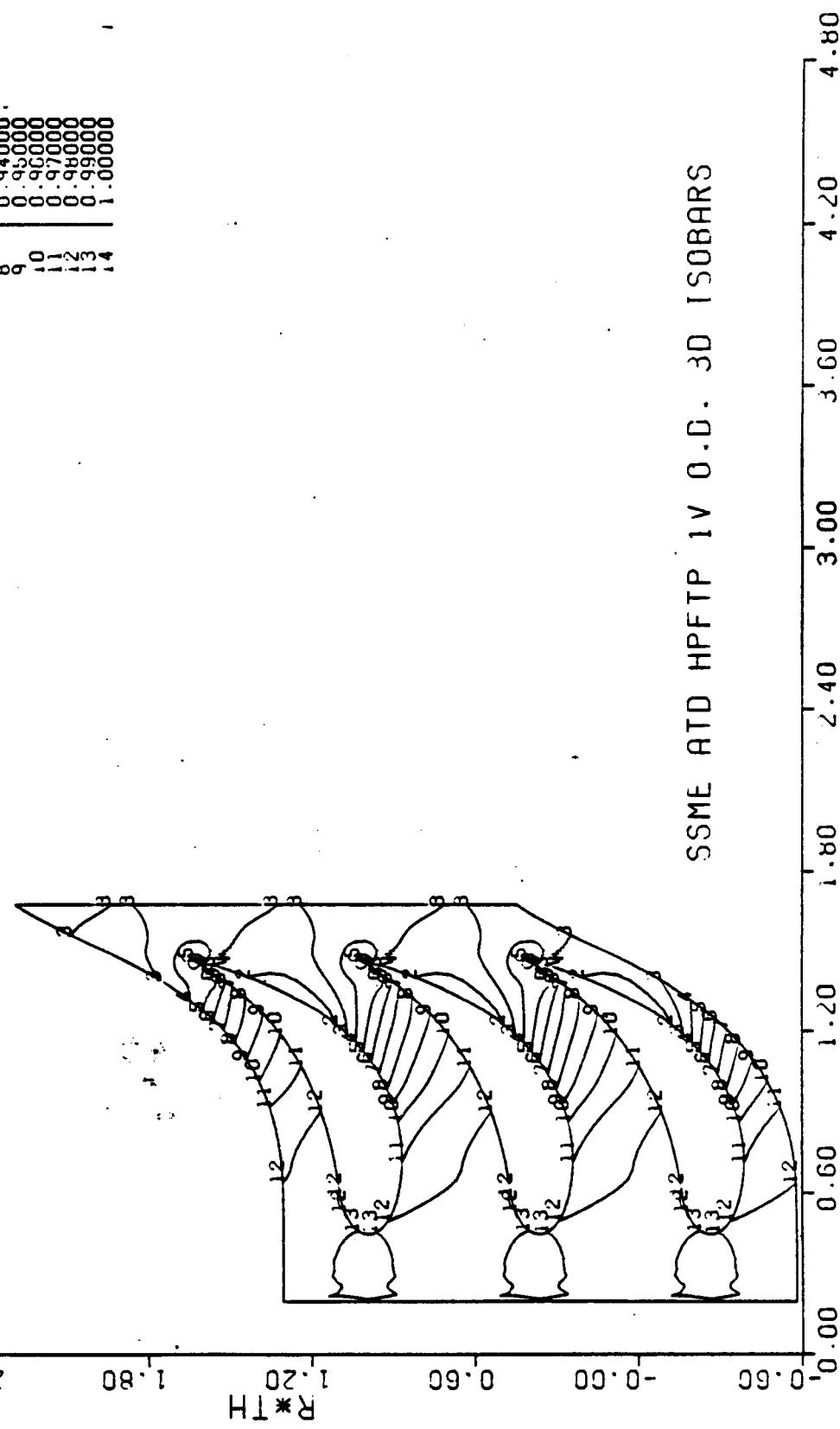
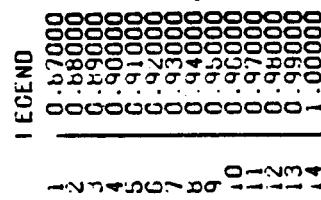
SOME ATD I.V I.D. 3D ISOMACH



KSI FILE: 1 NI 3D RINGGRID GRID INLET STRUT. R I. ROMET. C1-05-88. R
CZ/08/88 15.15.49

P / P_T

CONTOURS



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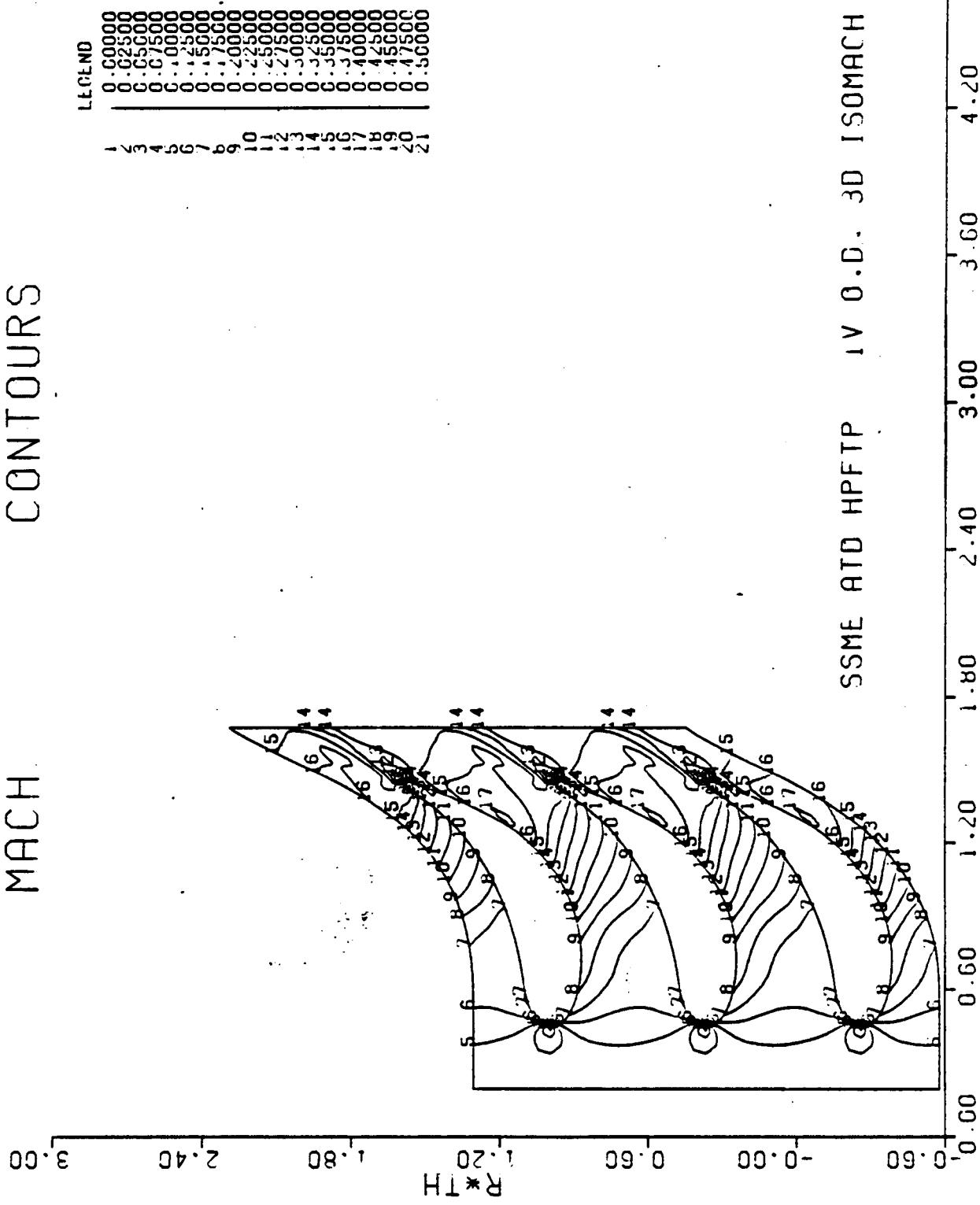
MACH

CONTOURS

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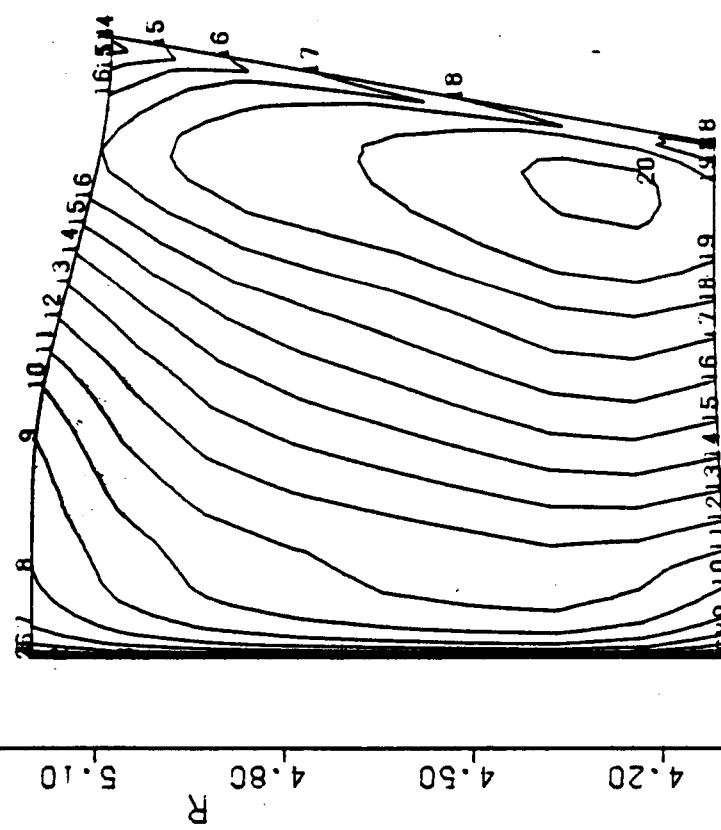
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MACH

CONTOURS

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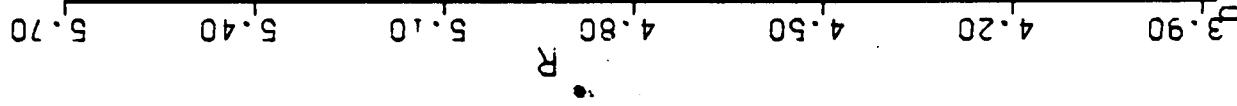
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P/P_T

CONTOURS

LEGEND

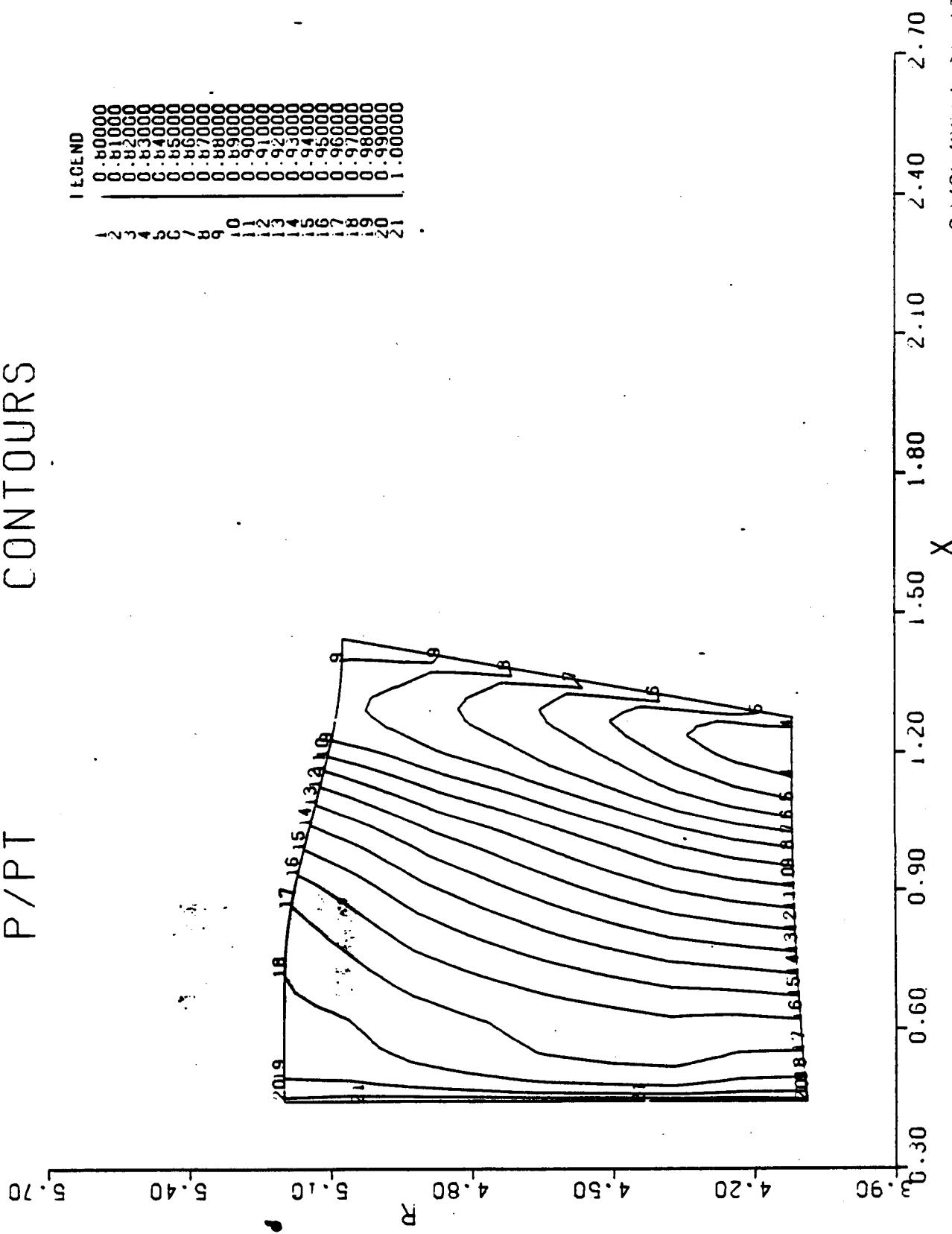
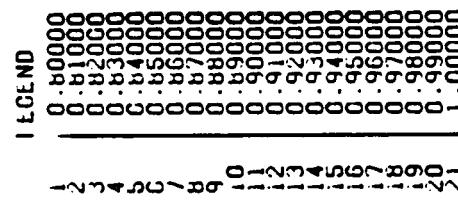
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0.5200
0.5300
0.5400
0.5500
0.5600
0.5700
0.5800
0.5900
0.6000
0.6100
0.6200
0.6300
0.6400
0.6500
0.6600
0.6700
0.6800
0.6900
0.7000



JSLICE= 1 NI 3D CYLINDRICAL C-GRID INLET STRUT... R. J. ROWLEY . G1-05-88 . R
02/08/88 14:31:42

P / PT

CONTOURS

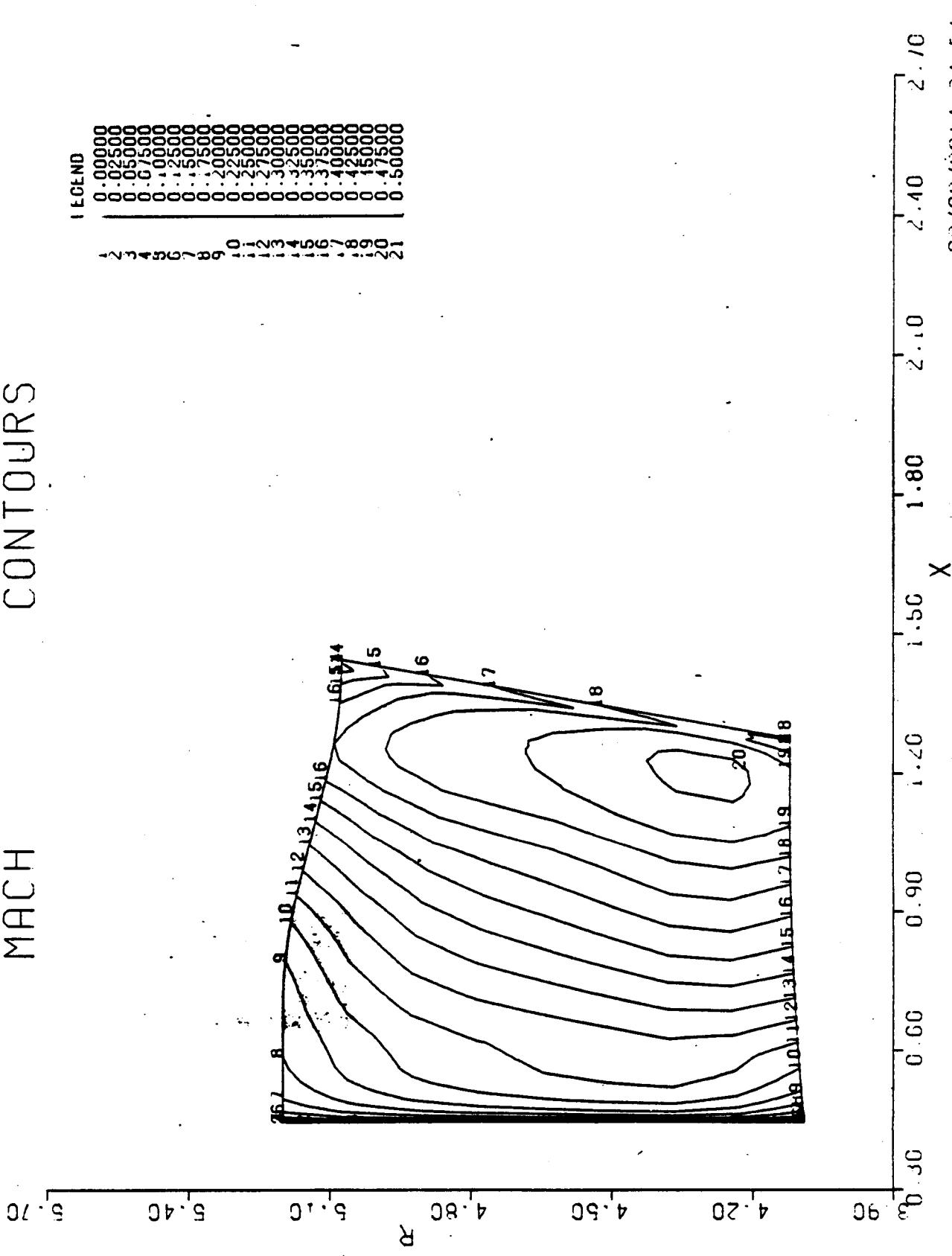


MACH

CONTOURS

LEGEND

0.00000
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0.05000
0.07500
0.10000
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0.15000
0.17500
0.20000
0.22500
0.25000
0.27500
0.30000
0.32500
0.35000
0.37500
0.40000
0.42500
0.45000
0.47500
0.50000



JSLICE=1 NI 3D CYLINDRICAL C-GRID INLET STRUT... R.J. ROWER... C1-05-88...R
C2/08/8814:24:54

U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 02/29/87

TIME 10:56:19

FIRST VANE R. J. REYNOLDS 06/11/87 RJR

FUEL 2 UZ60 RIF = 4.0Z RIE = 4.12

4.004 TURB

INLET EXIT

MACH NO. 0.125 0.514

GRS ANGLES 90.04 155.47

PRESSURE SIDE

REF. REYNOLDS. NO. *****

0.0100

0.0080

0.0060

0.0040

0.0020

0.0010

0.0000

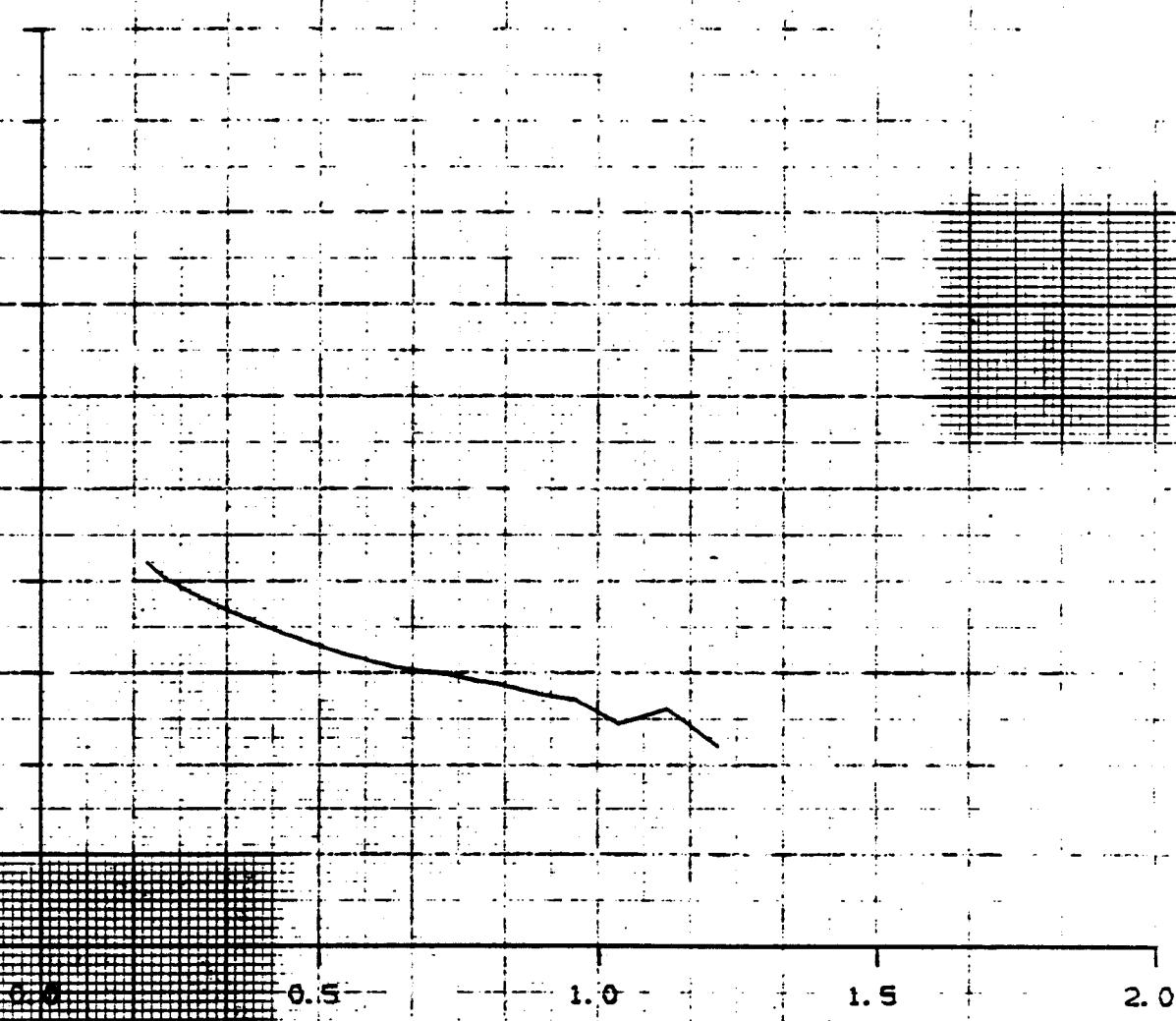
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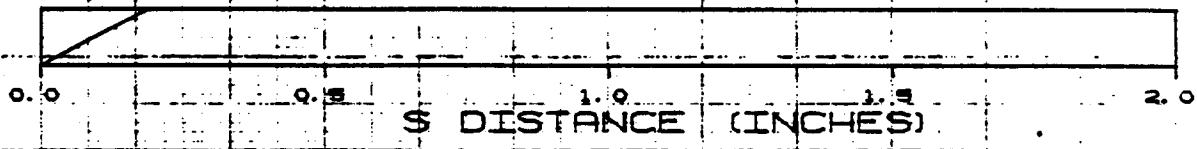
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0.0000



S DISTANCE (INCHES)

TRANSITION CHART



U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87

TIME 11:00:10

FIRST VANE L.R.J. RONEY 06/11/87. RJR

FUEL 2 U760 RIF 1.75 RTE = 4.36

4.002 HI

INLET

EXIT

MACH NO. 0.124

0.493

GAS ANGLES 89.88

161.81

PRESSURE SIDE

REF. REYNOLDS NO.

0.0100

0.0080

0.0060

0.0040

0.0020

0.0010

0.0008

0.0006

0.0004

0.0002

0.0001

0.0000

0.0000

0.0000

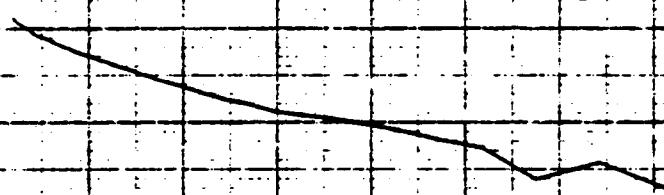
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0.0000

0.0000

0.0000

EDNOL 00001



S DISTANCE (INCHES)

TRANSITION CHART

S DISTANCE (INCHES)

2.0

2.0

U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87 TIME 11:05:26

FIRST VANE R. J. BONEY 06/11/87.. RJR

FUEL2 U760 RTE= 4.64 RTE= 4.60

4.002 TO

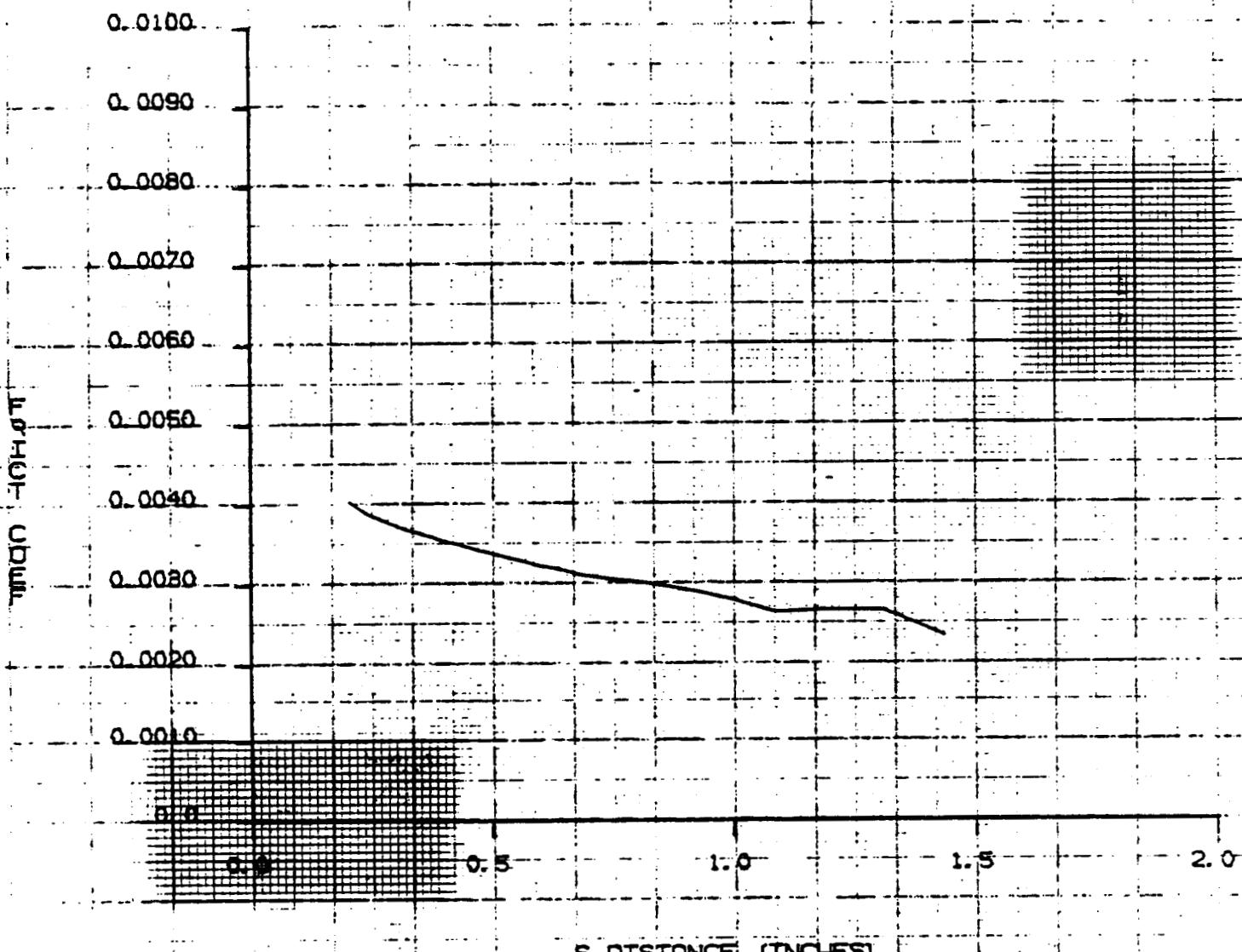
INLET EXIT

MACH NO. 0.118 0.469

GAS ANGLES 89.88 162.37

PRESSURE SIDE

REF. REYNOLDS NO. *****



TRANSITION CHART

S DISTANCE (INCHES)

2.0